THE SOCRATES$^{2.0}$ PILOT IN CITY OF AMSTERDAM

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Colophon

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1. ORGANISATIONAL SET-UP

In Activity 3 the functional design of the use case Optimising Network Traffic Flow has been described and was approved by the SOCRATES$^{2.0}$ Steering Group in October 2018. In Activity 4, during the preparation phase, this functional design was translated into detailed designs.

To ensure a proper execution, for the pilot site Amsterdam an Activity Management Team (AMT) was installed. This team consisted of the following officers:

- Pilot Site Lead: Giovanni Huisken
- Business manager: Jan Maarten van den Berg
- Alignement manager: Arthur Rietkerk
- Project assurance: Gerben Kiffen
- ICT liaison: Harry van Ooststroom
- Communication officer: Esther de Graaf
- Use Case ONTF lead: Giovanni Huisken
- Use Case SD lead: Marc Rood
- Use Case RW lead: Ruud van den Dries
- Use Case EZ lead: Jan Maarten van den Berg
- Optionally - Project manager: Tiffany Vlemmings

The AMT was active during preparation and execution of the pilot and met approximately 60 times to discuss necessary actions, take decisions and guide the development and execution of the Use Cases, including communication internally and externally and align with PMT.

Additional team meetings that took place during development and execution of the use cases at the Amsterdam pilot site:

- Pilot Site team meetings: all participating partners represented, bi-weekly meetings
- Develop & Operation team: focus team for ICT developments, bi-weekly meetings
- NL-Preparation team: representatives of all Road Authorities, meetings every 3 weeks
- SOCRATES$^{2.0}$ Operational team: representatives of the three TMC's, irregular ad-hoc meetings

1.1 Planning (phases)

It was decided that all four Use Cases were to be divided into three phases:

1. Development, Plateau 0 phase
2. Operational, Plateau I phase
3. Operational, Plateau II phase

The development phase would roughly take place from end of Activity 3 until November 2019. Then the operational first Plateau would take place from December 2019 – March 2020, while Plateau II would be in operation from April 2020 – June 2020. Details are described in chapters 2 – 13.

2. INTRODUCTION - ONTF

In Activity 3 the functional design of the use case Optimising Network Traffic Flow has been described and approved by the SOCRATES$^{2.0}$ Steering Group in October 2018. In Activity 4 this functional design is elaborated in multiple more detailed designs. Based on this latter design the pilot is developed.

2.1 Use Case description

The SOCRATES$^{2.0}$ ONTF use case describes how to Optimize Network Traffic Flow in the Amsterdam area.

FIGURE 1. SOCRATES$^{2.0}$ NETWORK

Figure 1 shows the road network forming the scope of the SOCRATES$^{2.0}$ project.

The network consists of a combination of National roads (A-roads), provincial roads (N-roads) and municipal roads (S-roads).

The network is divided in several links. A link is a one-directional connection between two decisions point. On a decision point the driver does make a choice about the next link in their route.

For each link, volume and speed is monitored. Production is defined as Volume X Speed. When volume increases, the production increases as well. However, when there's too much traffic, the speed will drop and therefore the production will no longer grow as expected, and finally it will fall due to a traffic jam. By monitoring volume and speed, it is possible to detect when volume starts to slow down compared to expected values, resulting in a 'problem state'. This the trigger to start network management activities. See Figure 2.

The required production for a network link is described as Key Performance Indicator (KPI). When the production starts to deviate from the required KPI this will result in problem state can occur.

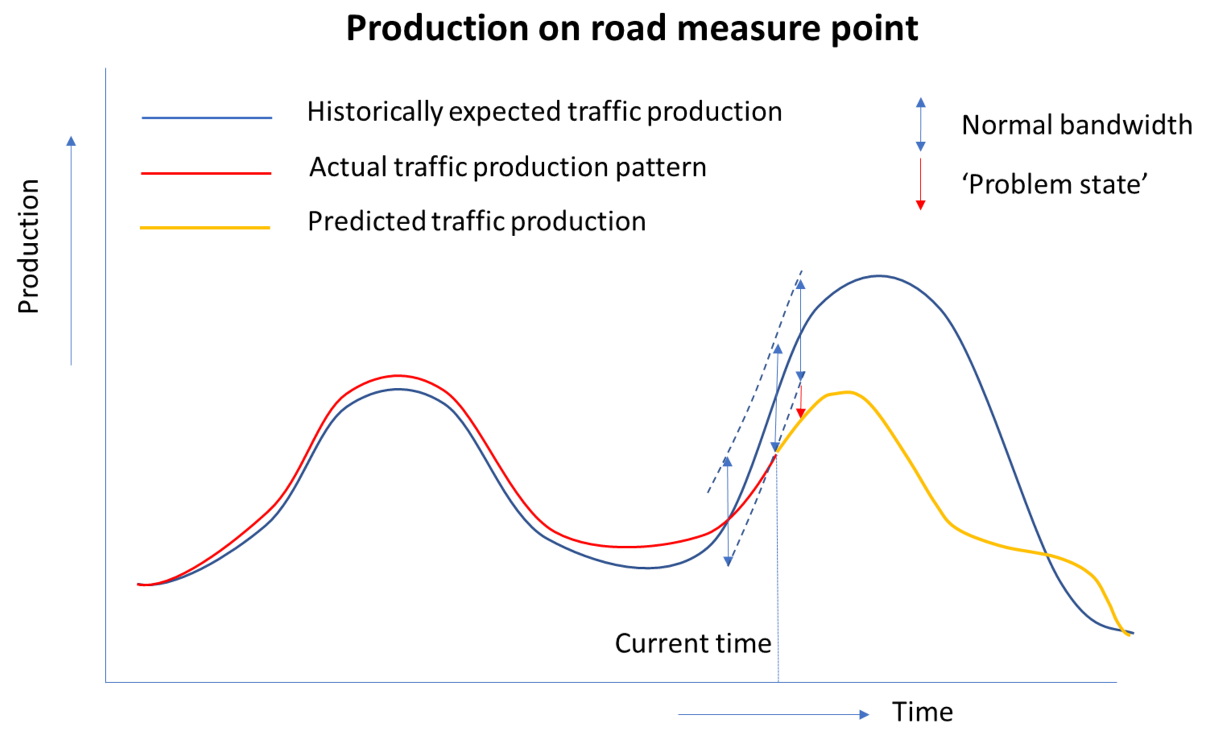


FIGURE 2. TRAFFIC PRODUCTION ON A LINK

Note: Figure 2 above suggests that traffic is managed when the current state deviates too much from the historic state. The suggestion is made to manage traffic also with regular states, e.g. send message to Service Providers when daily traffic jams start and traffic still can be rerouted.

To manage the traffic in the SOCRATES$^{2.0}$ area, information is exchanged between the different sub-systems in the area, see the sequence diagram Figure as taken from the Information Architecture [IA].

2.2 Functional overview (SOLL Act.3 vs. IST Start Act.4 vs. IST End Act.4)

Changes in relation to Activity 3 – functional design

Activity 3: Part 3: SOCRATES$^{2.0}$ services for PS-UC

	SOLL Act.3	**IST Start Act.4**
System overview with key functions	Data fusion & completion one of the key Network Monitor functions. Active services private service providers feedback to Network Monitor.	Limited data fusion and completion. No feedback loop for private services to Network Monitor. Only public active services in current state.

	Current active public and private services used in prediction and current state. Common goals (meaning public and private goals aligned). 'Virtual reward' system for all partners impact (public, private and intermediary). Automated services selection by Network Manager.	Only public goals. Reward system is part of service for road users only. Limited automated Network Manager (e.g. more toolbox configuration).
Cooperation models	Cooperation Model 6 with all intermediaries acting on a tactical level.	Cooperation Model 6, where intermediaries act, intermediaries act on a tactical/operational level.
Roles		No changes in required roles.
Intermediary		No changes in required intermediaries.
Actors		Not disclosed.
Pre-/post conditions		Conditions still apply.
Sequence diagram		No significant changes.

Staged deployment of functionalities

The operational stage (Dec '19 to June '20) is divided in 2 plateaus.

- The 1st plateau is the period from December 2019 until end March 2020.
    - 1st week of November: 'Company users' test
    - 2nd and 3rd week of November: 'Friendly users' test
    - 4th week of November (until end of June) and later: 'SOCRATES2.0 users' recruitment

- The 2nd plateau is the period from end March 2020 until end June 2020. New functionalities are added in plateau 2.

Plateau 1 functionalities:

- Fusion of data from NDW and one Service Provider to describe the current traffic on the ONTF network
- Tilted table from Network Monitor to Network Manager, containing:
    - Current speed and current volume per SOCRATES2.0 link on the ONTF network
    - Predicted speed and predicted volume per SOCRATES2.0 link on the ONTF network
    - Activated traffic management measures
- Distribution of Avoid Service Requests by the Network Manager to the Service Providers (in DATEX-II format)
- Distribution of Avoid Service Requests by the Network Manager to the TMCs (in DVM-X format)

Plateau 2 functionalities:

- Fusion of data from NDW and more than one Service Provider to describe the current traffic on the ONTF network
- Tilted table from Network Monitor to Network Manager, containing:

    - Current speed and current volume per SOCRATES$^{2.0}$ link on the ONTF network
    - Predicted speed and predicted volume per SOCRATES$^{2.0}$ link on the ONTF network
    - Activated traffic management measures
- Distribution of Avoid Service Requests by the Network Manager to the Service Providers (in DATEX-II format)
- Distribution of Avoid Service Requests by the Network Manager to the TMCs (in DVM-X format)
- Distribution of Reroute Service Requests by the Network Manager to the Service Providers (in DATEX-II format)
- Distribution of Reroute Service Requests by the Network Manager to the TMCs (in DVM-X format)
- Implementation of a Reward system.

Actual situation End of Operational period (IST End Act.4)

During the operational period, development did not stop. Almost all items in the total information chain underwent changes, notably the Network Monitor (changes of current traffic and prediction), Network Manager (steadily improving the functionality to generate appropriate Service Requests) and some back-end and end-user services from the Service Providers.

2.3 Active partners

Eleven SOCRATES$^{2.0}$ partners are active in the Optimising Network Traffic Flow use case Amsterdam.

Partner	Role in use case
BMW	Service provider (active involvement limited to chain testing)
City of Amsterdam	Road Authority
Province of North-Holland	Road Authority
Rijkswaterstaat	Road Authority / Network Manager
NDW	Data provider / Network Monitor / Strategy Table organiser
HERE	Data provider
MAPtm	Strategy Table organiser / Assessor
BrandMKRS	End user Service provider
Be-Mobile	Data provider / End user Service provider
TomTom	Data provider / End user Service provider
Technolution	Network Manager

3. INFORMATION ARCHITECTURE - ONTF

3.1 Sequence diagram

The **information architecture** (IA) is an elaboration of the sequence diagram originally produced for Activity 3. It contains processes (green) and interactions (red) between processes. The processes are functional and in general conducted by one stakeholder as an internal process. A process receives and collects data, enriches the data and produces information as a product. Information is sent via protocols to other processes in the architecture.

The functional process starts with step 1 (data and measures) and continues all the way to step 17 (accept / decline (DATEX-II), see figure 3).

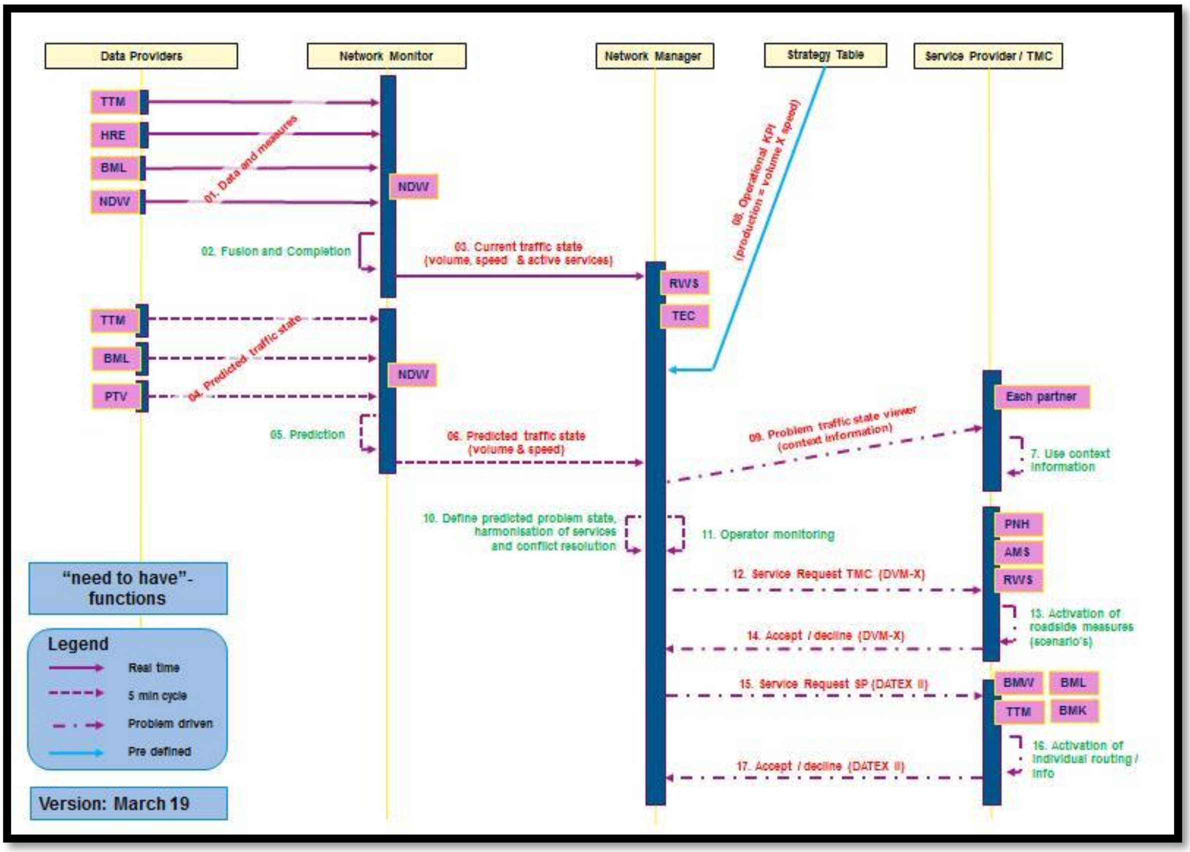


FIGURE 3. SEQUENCE DIAGRAM ONTF AMSTERDAM.

Note: the service requests 12 and 15 within figure 3 to TMCs and SPs are drawn sequentially here, however, they will be sent out in parallel.

3.2 Processes and interactions

Step 1: Data and Measures (NDW)

Data elements

Private and public data providers send actual data and measures to the network monitor (NDW). The collection of data and measures consists of multiple data streams from multiple partners:

a. **Traffic data of road authorities** (speed and traffic volume on a minute base) – most already available at NDW, so NDW will provide this data stream. Open action: volume data from city of Amsterdam + Provence, NDW to discuss with City and Provence
b. **Traffic data of data providers** (traffic speed on a minute base)
c. **Infrastructure capacity status** (temporary capacity changes), delivered by road authority and status of peak and regular lanes - open/closed) – most already available at NDW, so NDW will provide this data stream
d. **Incident[1] data of road authorities** (reports of accidents, incidents and other events (air pollution status). This info is essential to determine the **cause** of a service request.
e. **Status and incident data of data providers** (reports of accidents, incidents and other events)
f. **Active traffic management measures from road authorities** (e.g. VMS recommendation, ramp metering active). Start with rerouting services. This includes activated traffic management measures as a result of the service request of the Network manager.

Decision: Activated strategic routing services from service providers are too difficult to obtain. One of the reasons is that the amount of active service provider users is low.

Networks and links (NDW+RWS)

- The Monitoring Network is the road network that needs to be used for the collecting of data (all black, blue, red and green parts). This is also the network for prediction.
- The Optimization Network is the road network that needs to be optimized by the network manager (all blue, red and green parts).
- The Network monitor will aggregate data from different data providers to link level. These include: speed, volume, services and incident data.
- Additional effort is needed to aggregate the road authorities' measures/scenario's (operational level) to services on links (tactical level).
- A "link" is part of the Network between 2 important decision points for road users.
- For each coloured part in the network detailed excel files are available for link information.
  - The red network (RWS) has 50 links.
  - The green network (Amsterdam) has 30 links.
  - The blue network (Province NH and UT) has 10 links.
- Note that a green dot indicates additional data requirements for the UC smart destination. (further action is needed to identify the details).

Step 2: Fusion and completion (NDW)

The Network monitor needs to know what the traffic state is on the network and what measures are activated to influence that traffic state. If necessary, the Network monitor fuses all data from both public and private partners.

Fuse or not to fuse: that's the question:

- Fusion (and, if necessary, completion) of traffic **speed** data from public and private partners.

[1] Incident can be any type of disruption

- No fusion of **volume** data necessary, because there is only data from public partners.
- Fusion of **status and incident** data. Reports of incidents and other events from public and private partners.
- No fusion of status information of **peak and regular lanes**, because there are only data from public partners.

As part of the fusion there will be a quality check and validation on the data.

Step 3: Current traffic state (NDW)

Current traffic state is created by NDW. With a 1-minute interval the Network monitor creates a current traffic state and sends this to the Network manager. In this stage the current traffic state is a data stream, only recognisable by systems.

The use of a tilted data table. Instead of separate data streams, there is a data stream in which for each link in the network, the current state on traffic flow, status information and services is provided.

The predictions will not be based on the common current traffic state, but on each company's own data and/or own data suppliers.

Evaluation question: what is the specific value of the current state, is its used for service requests or is the prediction only sufficient?

Decision: The current traffic state is not needed for service providers. The reason being that service providers receive a data rich service request via DATEX-II from the Network manager (see TMEx profile documents for strategic routing). So, service providers will not use this information.

The current traffic state is needed for in TMCs as context information because the service request via DVM-Exchange only contains an ID of the service. So, more context information is needed. See step 7 for "who uses what".

Difference between DATEX II and DVM-X service requests

		TMC	SP
Hello	Establish communication and recognition	DVM-Exchange	DATEX II (tmp/cis)
What	Problem	Context & pre agreed	DATEX II (tmp/cis)
Where	Location	Pre agreed	DATEX II (tmp/cis)
Why	Reason	Context & pre agreed	DATEX II (tmp/cis)
How	Avoid/strength/incentive	Pre agreed	DATEX II (tmp/cis)
When	Timing	?	DATEX II (tmp/cis)

Step 4: Predicted traffic states from TTM, BML and NDW/PTV (NDW)

At the moment there are three partners (NDW, TomTom and Be-Mobile) who are interested in providing a "prediction engine". The predictor calculates the prediction of the traffic state based on current data and advanced prediction techniques.

It is assumed that the prediction engines use own data together with (fused) data from NDW.

The prediction function should be able to plug into the Network monitor base system; there is no direct connection between the predictor engine and the Network manager.

The prediction engines can run simultaneously for the whole period.

The predicted traffic state is calculated every 5 minutes with a default horizon of 15 minutes. The 15-minute value is about the speed and volume.

TomTom and Be-Mobile predictions are not using active road side services.

The PTV prediction currently only use the lane status from highways (MSI). PTV will also use the road side inflow/outflow services.

Step 5: Prediction processing (NDW)

NDW receives the predictions from 3 partners.

The Network monitor selects 1 of the 3 predictions for the Network manager. It is decided that here will be 3 consecutives periods of 2 months, starting 1st of September. After that 3 consecutives periods of 1 month will follow. This gives the prediction partners the possibility to improve functionality in the second half of the operational period.

Map matching needs to be done in order to feed the network managers Network.

And NDW will send the predicted states to the Network manager.

Step 6: Predicted traffic state (NDW)

With a 4-minute interval the Network monitor creates a predicted traffic state and sends this to the Network manager. This is the primary process.

Decision: The predicted traffic state is <u>not</u> needed for service providers. The reason being that service providers receive a data rich service request via DATEX-II from the Network manager (see TMex profile documents for strategic routing). So, service providers will <u>not</u> use this data. However, service providers get access to MobiMaestro-web. This enables the service provider to view the context information.

The predicted traffic state is needed for in TMCs as context information because the service request via DVM-Exchange only contains an ID of the service. So, more context information is needed. See step 7 for who uses what?

Step 7: Use of the current, predicted and problem state (TMCs)

TMCs are users of the “current, predicted and problem state”. TMCs need this information to optimise their process in combination with service requests. TMCs tend to visualize this in order to give the traffic operators a continuously update and context information to interpret ‘service requests’.

Delivery options:

a. Mobi-Maestro web viewer as a separate screen
b. Integrate Mobi-Maestro solution, no separate screen needed.

TMC-RWS and TMC AMS wishes to use the integrated MobiMaestro solution, no separate screen needed.

TMC-PNH: wishes to use the MobiMaestro web viewer as a separate screen.

However, all TMCs have accepted the integrated MobiMaestro solution as the best workable solution.

Step 8: Define predicted problem state (TEC / RWS)

The network manager defines the predicted problem state based on the predicted traffic state and the KPIs. The Network manager monitors the KPIs continuously.

The aim is to optimize the network traffic in the region of Amsterdam. The road network in this area consist of a combination of national roads, provincial roads and municipal roads. This road network is

monitored continuously and when deviations occur the SOCRATES$^{2.0}$ Network manager will start a network optimization effort in order to optimize the traffic flow and minimize traffic jams.

This is done in a couple of steps:

- The road network is divided in 114 links.
- For the links in the network the productivity is determined. Productivity is defined as ‘speed x volume’ per link. This is done for every 5 mins.
- When the measured actual productivity is deviating too much from the historical pattern, this is a trigger for the SOCRATES$^{2.0}$ network manager to evaluate alternative services.

This is described in more detail in the following paragraphs.

Step 9: Problem state context information (TEC / RWS)

This is about the service request context information.

The Network manager creates a current, predicted and problem state for the Network manager operators (TMC-RWS).

The current state is provided real time (every minute) while the predicted and problem state is provided every five minutes. These products are (in the 5-minute cycle) synchronised so that they are based on the same timestamp.

Step 10: Harmonisation of services, impact calculation and conflict resolving (TEC / RWS)

The network manager creates or chooses the most effective set of services to solve or ease the problem state of the entire network.

- The network manager can choose from multiple services from the pre-defined toolbox by the Strategy Table.
- 2 types of routing services are identified:
  - 1) “avoid link A” → SP/TMC decide how to reroute away from link A.
  - 2) “avoid route A and reroute traffic via alternative routes B and C”
- Inflow and outflow service requests are out of scope for SPs.
- Inflow and outflow requests could be sent to TMCs. TMC Amsterdam and TMC NH have got a lot of means to activate an inflow/outflow requests.
- Services are pre-agreed “measures” from service providers and traffic management centres.
- The impact is an estimated parameter for every service. On a monthly basis, traffic engineers monitor and if needed adjust the impact parameters to align them with the “truth”. This “truth” is based on the assessor’s report and expert judgement of the RA engineers/rKCO. Further elaborating of the impact is needed.
- If a service request is sent to service providers, all service providers will receive the same service request.
- Multiple services are combined without internal conflicts. However, it is possible that “instrument” conflicts happen on operational level in the TMC. The traffic operator should prioritise in this case.
- The aim is to make this step fully automated with limited operator intervention.

Toolbox

Strategy table and Network manager have discussed current toolbox and implementation in the Network Manager (MobiMaestro).

Toolbox							
Links	Available Services						
	TMC1	TMC2	TMC3	SP1	SP2	SP3	SP4
1	S1,2			S5	S6	S7	S8
…	S1			S5	S6	S7	S8
…		S3		S5	S6	S7	S8
…			S4	S5	S6	S7	S8
114				S5	S6	S7	S8

The practical implementation of toolbox in MobiMaestro has been implemented by Rijkswaterstaat.

Step 11: Operator monitoring (RWS)

This data stream is visualised by MobiMaestro for TMC-RWS because the problem state is needed to understand why service requests are received. The NDW viewer will not be used within SOCRATES$^{2.0}$.

Just monitoring by operator. Logging of issues.

Same as step 7 for TMC RWS.

Step 12: Service request and step 14 - accept/decline (TEC/RWS)

The network manager sends services requests to traffic management centres.

- A service request can be accepted or declined by the receiving partner.
- Only accepted services requests are used for impact validation by the assessor.
- Service requests to TMC use the DVM-X protocol.
- Service request information elements are:
    - Message ID (‘volgnummer’)
    - Toolbox service ID

Step 13: Activation of roadside measures - scenario’s (TMCs)

Internal process traffic management centre.

All requests to TMC are send via DVM-Exchange.

Translation of service request to response plan configuration in MobiMaestro has been taken into account by adjusting existing response plans.

Step 14: Accept / decline (DVM-X) (TMCs)

The TMC either accepts or declines the request.

Step 15: service requests to SP and step 17 accept/decline (TEC/RWS/NDW/SPs)

The network manager sends services requests to service providers and traffic management centres.

- A service request can be accepted or declined by the receiving partner.
- Only accepted services requests are used for impact validation by the assessor.
- Service requests to SP use the DATEX II tmp/cis protocol.

- Service request information elements are:
  - Message ID (‘serial number’)
  - Location reference of effected link (where is the problem)
  - Direction of the link (e.g. eastbound, westbound, ...)
  - Strength of the requested service: weak, medium or strong (default medium)
  - Location reference of alternative routes
  - Reason of SR: Incident classification (e.g. accident, debris, weather, roadworks, event, …)
  - duration of incident on that location
  - Time: start-time & expected end-time of request

Step 16: Service activation Service Providers (SP)

Service activation by service providers is done automaticly.

Service providers will balance common and individual preferences before advising customers to follow the strategic route requested by the Network manager.

Step 17: Accept / decline (DATEX-II) (SP)

The SP either accepts or declines the request.

4. SYSTEM ARCHITECTURE - ONTF

4.1 System / Application overview

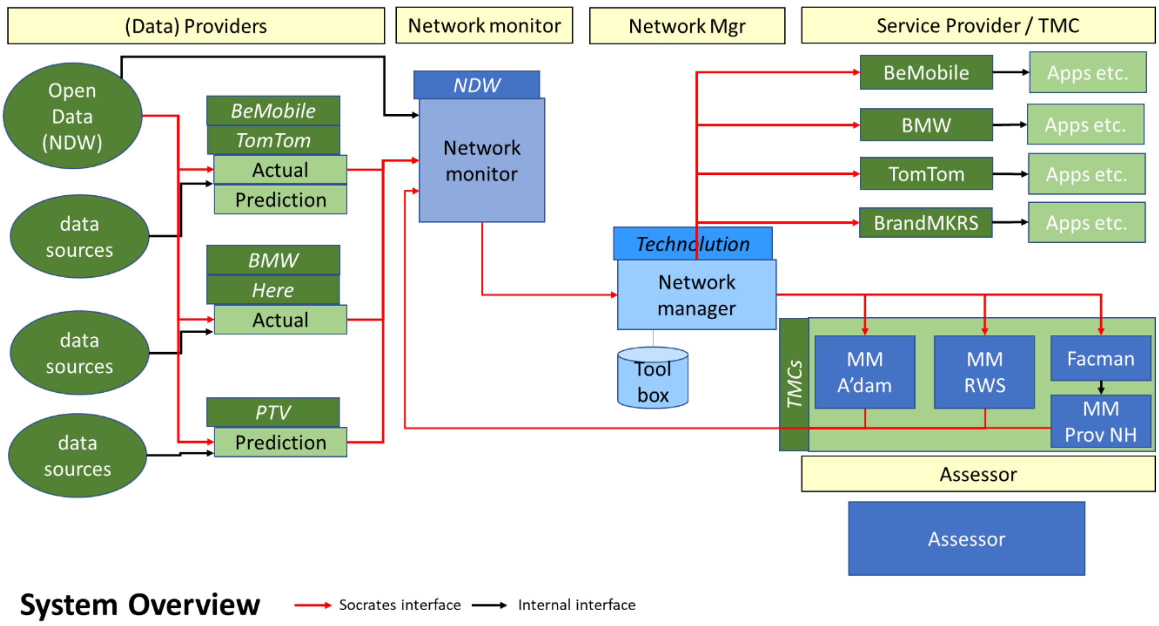


FIGURE 4. SYSTEM OVERVIEW ONTF AMSTERDAM

SOCRATES$^{2.0}$ consists of five main components (figure 4):

- (Data) providers: traffic information is gathered in different ways and by different entities: NDW gathers traffic intensity and speed information from loops, service providers do gather speed information from e.g. FCD. NDW provides the gathered information as 'open data' to providers.

From this information the (data) providers compute an actual and predicted traffic state.
The TMCs provide information about the current outstanding measures.
NDW matches all provided data to their own map.

- The Network monitor gathers all actual and predicted traffic states and transmits it to the SOCRATES$^{2.0}$ Network manager.
- The SOCRATES$^{2.0}$ network manager evaluates the current and predicted traffic states. It compares the situation with the KPIs as stored in the KPI-table. If the current and / or prediction deviates too much from the KPI value, measures must be taken in an effort to keep the traffic production at the required KPI level.

Note: actual criteria for maximum deviation are under discussion.

All possible measures and their expected impact on traffic production are stored in the Toolbox.
The SOCRATES$^{2.0}$ network manager uses a network optimizing algorithm that calculates all combinations of possible traffic measures as offered through the toolbox in order to find the optimal solution. The network manager translates this solution in one or more service requests that results in rerouting, limit input, promote output. These are sent to the involved TMCs and to the SPs.
A TMC can respond that a requested service is accepted, rejected, or that it is already enabled. Based on this feedback the network manager can further optimize the network.

- The TMCs and SPs receive service requests. E.g. enable access dosing on a highway access point for a TMC or avoid A9 for a service provider.

- The assessor component receives all relevant information and monitors the effectiveness of SOCRATES$^{2.0}$ measures for both TMCs and SPs. The assessor does not do that real time, but once per month.

The interfaces are described in more detail in the next paragraphs.

4.2 Overview interfaces

An overview of the identified interfaces is shown in the application architecture. Dotted lines represent manual processes, full lines represent automated processes (figure 5).

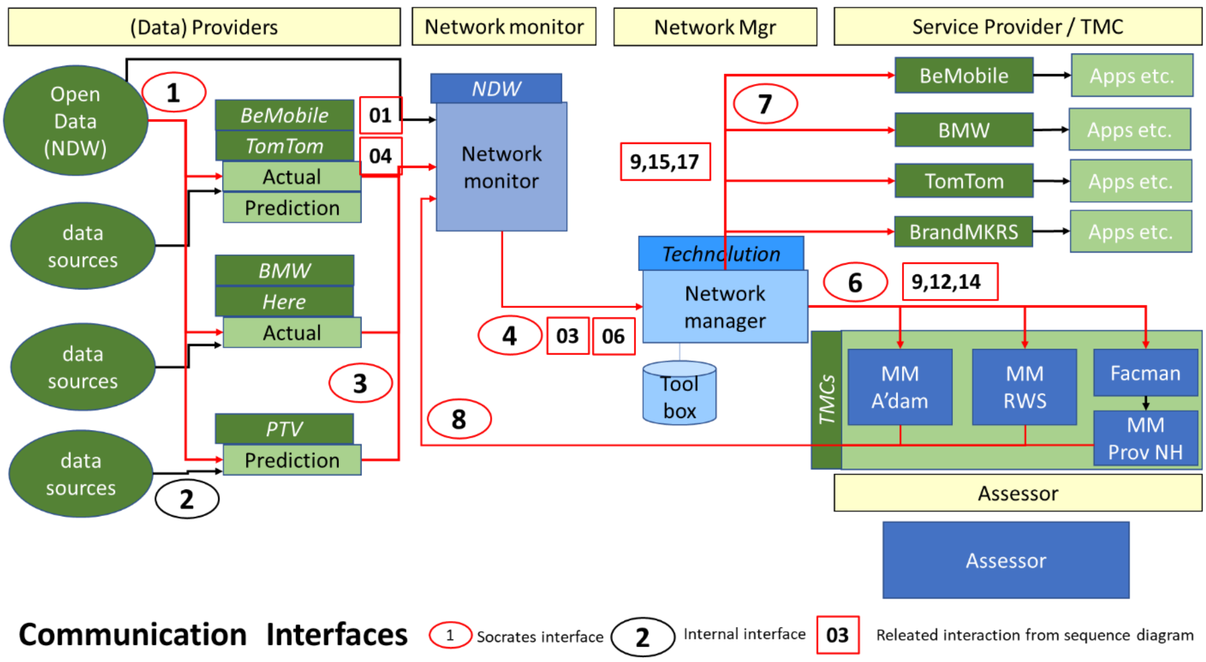


FIGURE 5. APPLICATION OVERVIEW WITH INTERFACED IDENTIFIED ONTF AMSTERDAM

Interface 1 – Open data to Data providers

MessageID	**I1.0A**
Message:	**Speed/volume**
Protocol:	Providers: proprietary
	NDW to data providers: DATEX-II
Frequency:	Every minute
Related sequence message ID:	None
Related TMEX dataset:	None

Message information

Field	Remark
Data	Date & time stamp

Volume	Number of vehicles per link
Speed	Average speed
Travel time	Derived from average speed
Infrastructure status	On the selected link // to be provided by NDW
Event data TMC	Event information as provided by Road Authorities

Interface 2 –Data Source to Data providers

Interface 2 is a proprietary interface from Data source to Data provider, used internally by the Data provider. It is not described here.

Interface 3 – Data provider to Network monitor

Message ID **I3.01,04**

Message: **I3.01: Actual traffic state,**

I3.04: Predicted traffic state

Messages are identical, only a flag indicates if data is actual or predicted.

Protocol: Choice of data provider

Frequency: The actual state is given every minute. The prediction is given every five minutes.

Related sequence message ID: 01, 04

Related TMEX dataset: Speed & flow data

Incidents

Message information

Field	**Remark**
Data	Date & time stamp
LinkID	ID of the data provider network link for which the traffic state is given
Travel time	Average travel time per link
Volume	Optional: Number of vehicles per link
IsPrediction	TRUE= Predicted state, FALSE=Actual traffic state
PredicitionTime	If message is a Prediction, this fields shows for which time the Prediction is made.

Interface 4 – Network monitor to Network manager

MessageID:	**I4.03,06**
Message:	**I4.03 Actual traffic state**
	I4.06 Predicted traffic state
Protocol:	DATEX-II
Frequency:	The actual state is given every minute. The prediction is given every five minutes.
Related sequence message ID:	3, 6
Related TMEX dataset:	None

The Network monitor does receive the Actual traffic states and the predicted traffic states. Possibly it also has an own actual and predicted traffic state. From the available states, the Network monitor sends one actual state per minute to the Network manager. From the available prediction states, one is sent to the Network manager every five minutes.

- Current Speed
- Current Flow
- Incidents (in eerste instantie van wegbeheerders; later mogelijk 'crowd sourced')
- Activated measures:
    - DVM services by TMC's (via DVM Exchange)
    - Images message signs (MSI's) – red cross, falling arrow, speed limit
    - Prediction of Speed (15-minutes horizon)
    - Prediction of Flow (15-minutes horizon)
    - Speed Reference
    - Flow Reference

Interface 5 – Network manager to Scenario evaluation

Interface is declared obsolete within the current scope of the project.

Interface 6 – Network manager to TMCs

MessageID:	**I6.09**
Message:	**Problem state viewer**
Protocol:	DVM-X
Frequency:	2 minutes
Related sequence message ID:	09
Related TMEX dataset:	None

Message information

Field	Remark

MessageID: **I6.12**

Message: **Service Request**

Protocol: DVM-X

Frequency: When necessary, a couple of times per day, estimation: max 10 / day.

Related sequence message ID: 12

Related TMEX dataset: None

Message information

Field	**Remark**
ID	Service Request ID
ReqService	ID of requested service
Strength	Weak, medium, strong
AlternativeRoute	Location alternative route (OpenLR)
Reason	E.g. accident, debris, weather, roadworks, event
StartTime	
EndTime	

MessageID: **I6.14**

Message: **Service Request Response**

Protocol: DVM-X

Frequency: After sending I6.2.

Related sequence message ID: 14

Related TMEX dataset: None

Message information

Field	**Remark**
ID	Service Request ID for which response is given.
Response	Response to the request. Possible values: - Accepted - Rejected - ---

Interface 7 – Network manager to Service Providers

MessageID: **I7.09**

Message: **Problem state**

Protocol: DATEX-II (with translator to MDM for Munich)

Frequency: when requested

Related sequence message ID: 9

Related TMEX dataset: Strategic Routes

** All Service Providers receive the same Service Request.

Avoid link + alternative route(s)

Message information

Field	Remark

MessageID: **I7.15**

Message: **Service Request**

Protocol: Datex-II

Frequency: Whenever necessary, a couple of times / day.

Related sequence message ID: 15

Related TMEX dataset: TMPlan exchange

Message information

Field	Remark
ID	Service Request ID
ReqService	Requested service.
StartTime	Start time of the requested service
EndTime	Expected end time of the requested service

MessageID: **I7.17**

Message: **Service Request Response**

Protocol: Datex-II

Frequency: 1x After Service Request

Related sequence message ID: 17

Related TMEX dataset: TMPlan Exchange

Message information

Field	Remark
ID	Service Request ID for which response is given
Response	Response to the request. Possible values: - Accepted - Rejected - ….

Interface 8 – TMCs to NDW

MessageID **I8.01**

Message: **Active measures messages**

Protocol: DVM-Exchange

Frequency: On occurrence

Related sequence message ID: 01

Related TMEX dataset: None

Field	Remark
Link	ID of SOCRATES$^{2.0}$ link Is 'Link' enough detail? (e.g. One link can contain a section with and without 'spitsstrook', or multiple drips
ActiveMeasureTMC	Description of active measure
ActiveMeasureSP	

4.3 Overview Assessor interfaces

All SOCRATES$^{2.0}$ components log their actions and make these actions available to the Assessor. The assessor evaluates the actions and how effective they are, see figure 6.

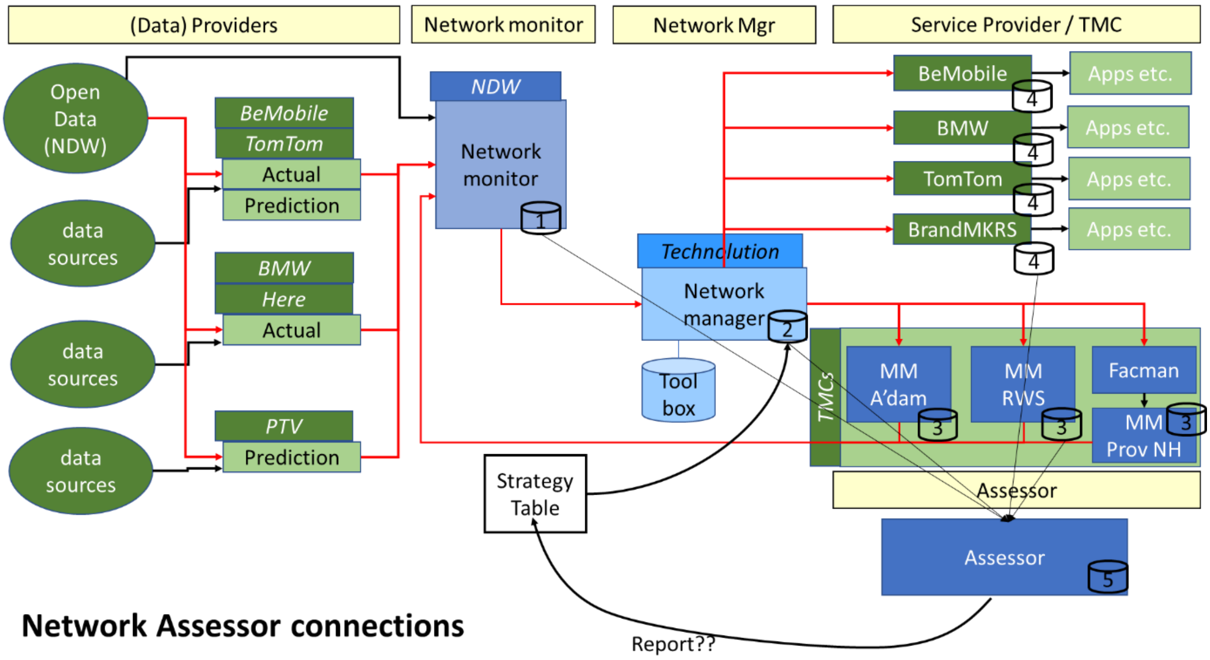


FIGURE 6. OVERVIEW OF ASSESSOR RELATED INTERFACES ONTF AMSTERDAM

(1) The network monitor stores:
- Received current states from Data providers
- Received prediction states from Data Providers
- Own current & predicted states
- The Current and predicted state sent to the Network manager

(2) The network manager stores:
- Outcome of scenario evaluation
- Service requests sent to service providers and TMCs
- Service responses received

(3) The TMCs store received service requests, and the corresponding response.

(4) The Service providers store received service requests, and the corresponding response. Preferably also if users have followed the advice or not (in aggregated manner).

(5) The assessor stores the evaluation report of all data.

All stored data is sent to the Assessor once / week.

4.4 Interfaces per partner

The SOCRATES$^{2.0}$ partners are responsible for the delivery of different types of data. This corresponds to the identified interfaces. This chapter lists the interfaces used by each partner. Each interface has two 'sides': one side is providing the data, the other side is receiving and consuming the data.

The interface numbering of figure 6 is used.

Be-Mobile

Supported interfaces

Interface	Message	Role	Remark
I1.A	Speed/volume	Consumer	
I1.B	Measures	Consumer	
I3.01	Actual Traffic state	Provider	It contains at least the information like described in Interface 3. The format however is proprietary and discussed with NDW.
I3.04	Predicted traffic state	Provider	
I7.09	Problem state	Consumer	
I7.15	Service request	Consumer	
I7.17	SR Response	Provider	

Assessor information

(4) Service requests received and service request response

BMW

Supported interfaces

Interface	Message	Role	Remark
I1.A	Speed/volume	Consumer	
I1.B	Measures	Consumer	
I3.01	Actual Traffic state	Provider	It contains at least the information like described in Interface 3. The format however is proprietary and discussed with NDW.
I7.09	Problem state	Consumer	
I7.15	Service request	Consumer	
I7.17	SR Response	Provider	

Assessor information

(4) Service requests received and service request response

HERE

Supported interfaces

Interface	Message	Role	Remark

I1.A	Speed/volume	Consumer	
I1.B	Measures	Consumer	
I3.01	Actual Traffic state	Provider	It contains at least the information like described in Interface 3. The format however is proprietary and discussed with NDW.
I7.15	Service request	Consumer	
I7.17	SR Response	Provider	

Assessor information

(4) Service requests received and service request response

BrandMKRS

Supported interfaces

Interface	Message	Role	Remark
I7.09	Problem state	Consumer	
I7.15	Service request	Consumer	

NDW

Supported interfaces

Interface	Message	Role	Remark
I1.A	Speed/volume	Provider	
I1.B	Measures	Provider	
I4.03	Actual Traffic state	Provider	
I4.06	Predicted traffic state	Provider	

Assessor information

(1) Received Actual and Predicted traffic states

(1) Actual and Predicted traffic states sent to Network manager

PTV

Supported interfaces

Interface	Message	Role	Remark
I3.04	Predicted traffic state	Provider	

Technolution

Supported interfaces

Interface	Message	Role	Remark
I4.03	Actual Traffic state	Consumer	
I4.06	Predicted traffic state	Consumer	
I6.09	Problem state	Provider	
I6.12	Service Request	Provider	
I6.14	SR Response	Consumer	
I6.14	Problem state	Provider	
I7.15	Service request	Provider	
I7.17	SR Response	Consumer	

Assessor information

(2) Actual and predicted problem states

(2) Service request sent to TMCs

(2) Service request sent to Service Providers

TomTom

Supported interfaces

Interface	Message	Role	Remark
I1.A	Speed/volume	Consumer	
I1.B	Measures	Consumer	
I3.01	Actual Traffic state	Provider	It contains at least the information like described in **Error! Reference source not found.**. The format however is proprietary and discussed with NDW.
I3.04	Predicted traffic state	Provider	
I7.09	Problem state	Consumer	
I7.15	Service request	Consumer	
I7.17	SR Response	Provider	

Assessor information

(4) Service requests received and service request response

5. INTRODUCTION - SD

In Activity 3 the functional design of the use case Smart Destination has been described and finalised. In Activity 4 this functional design is translated in a technical design. Based on this design the pilot is developed.

5.1 Use case description

Main problem

The main problem at events in the Amsterdam Arena area is the sub-optimal traffic in- and outflow before and after an event and the sub-optimal parking choice distribution in the area.

The problems are caused by:

- Visitors have little knowledge about parking location & occupancy
- Routing services do not consider parking guidance & occupancy
- Routing services do not consider recommendations of road authorities to optimize outflow
- Trip origin is not considered in route recommendation

Mission

The mission of the use case is to ensure a satisfactory journey for the event visitors by improving traffic flow distribution (in-flow/out-flow) over space and time using optimized dynamic parking during event and in the event neighbourhood.

Sub-missions are:

- To provide people a satisfactory travel experience to a parking location, in particular better information and guidance
- To improve inflow traffic and parking choice distribution in order to reduce the outflow peak.

5.2 Functional overview (SOLL Act.3 vs. IST Start Act.4 vs. IST End Act.4)

Changes in relation to Activity 3 – functional design

	Activity 3	Activity 4
3.1 System overview		For SOCRATES$^{2.0}$ no data on actual traffic state is sent to the Network Manager OMC. The OMC is an existing role and has already sufficient insight in the actual traffic state.
3.2 Cooperation Model	Cooperation Model 3 or 5 (depending on events with data exchange only, or events with coordinated services)	No changes
3.3 Roles		Because no data on the actual traffic state is needed, the data provider roles on road data are removed.
3.4 Intermediary		There will be no real strategy table. The strategy table role is embedded in the evaluation meeting after an event.

3.5 Actors	Not disclosed
3.6 Pre/post-conditions	No changes
3.7 Sequence diagram	There will be no exchange of data on the actual traffic state or historic origin-destination. Also, there will be no prediction on the parking occupancy.

Staged deployment of functionalities

The operational stage (March ’20 to July ’20) was divided in 2 plateaus.

- The 1st plateau was the period from March 2020 until end May 2020.
- The 2nd plateau was the period from June 2020 until end July 2020. New functionalities would be added in plateau 2.

Plateau 1 functionalities:

- Public and private parking data is sent to Network Manager OMC
- Data on road closures is sent from OMC to service providers
- Service requests with the parking status and recommended routes is sent from OMC to service providers
- In the end user service, a parking location (location depends on the origin of the user) is presented as the destination instead of an event location
- In the end user service, the parking location and/or the route will be changed during the trip, if the parking is almost full (information in the service request), if the recommended route is changed by the OMC (information in the service request) or if roads are to be avoided due to measures implemented by the traffic management centres (in the data on road closures)
- (option) A map with a walking route to the event location is presented in the end user service after parking the car.

Plateau 2 functionalities:

- Public and private parking data are fused to a common picture and is sent to the service providers

Actual situation End of Operational period (IST End Act.4)

Due to the outbreak of the Covid-19, all events in the Netherlands were canceled from March 2020 onwards. Unfortunately, this meant that the use case could not be put into practice. Only 4 technical chain tests and a field test with friendly users could be held.

The elaboration of the use case has not progressed further than plateau 1.

During de elaboration of plateau 1, it turned out to be too difficult for to process the recommended routes from the service requests. Both parties have indicated that they will adjust the parking destinations in response to the information in the service request. Based on their own traveltime data, they calculate the fastest route, taking into account any closed roads (as passed on in the data feed with road closures), but not using the recommended routes from the service request.

Because routes from the service request are not used, they are not offered as a service at the outflow. For the outflow, the service request only includes a recommended route that cannot be processed.

5.3 Active partners

Eight SOCRATES$^{2.0}$ partners are active in the Smart Destination use case Amsterdam.

Partner	Role in use case
City of Amsterdam	Data provider (parking data) / Network Manager / Road Authority
NDW	Network Monitor (only in plateau 2) Technical enabler datafeed road closures
Technolution	Technical enabler datafeed service requests
MAPtm	Assessor
TomTom	End user Service provider
Be-Mobile	End user Service provider
BrandMKRS	End user Service provider Data provider parking data (only in plateau 2)
BMW	Service provider for user evaluation use case (no end user service)

5.4 Generic description of end user services

The service offers road users smart individual route advice to a free parking space. In case of an event, when a visitor (and user of the navigation services of the SOCRATES$^{2.0}$ partners) asks for a route to the Johan Cruijff Arena and/or ZiggoDome and/or AFAS Live Music Hall, he is presented with the possibility to choose an parking location as destination instead of the event location itself. The parking locations that are presented, depend on the origin of the visitor. In order to spread traffic across the area and avoid large flows of crossing traffic, visitors from the East, for example, are guided via the A1 and A9 to parking locations in the southeast of the Amsterdam Arena area. The selected parking locations are in line with the response plans of the road authorities.

On the way to the parking location, the route is constantly updated by the service providers, taking into account the travel time on the route.

At the same time, road authorities are monitoring the traffic and parking situation in the Operational Mobility Centre (OMC). This OMC fulfils the role of network manager in this SOCRATES$^{2.0}$ use case. The OMC can decide on traffic measures (implemented by the traffic management centres) and on service requests to service providers (with recommendations for routes and parking garages). By processing the service request by the service providers, visitors can be offered a different route or parking destination in their navigation, so that they always have the fastest route to a free parking space.

Arriving at the destination, the user receives a map with a walking route to the event location (optional).

Key elements of the service are:

- Pre-trip: Choose a parking location as the destination (instead of an event location)
- Pre-trip: The parking locations presented depend on the origin of the user
- On the way: change parking location (and possibly route) if the parking location is almost full
- On the way: change route (and possibly parking location) in case of higher travel time
- On the way: change route (and possibly parking location) in case of implemented measures by the traffic management centres (road closures)
- Post-trip optional: A map with a walking route to the event location

6. INFORMATION ARCHITECTURE - SD

6.1 Sequence diagram

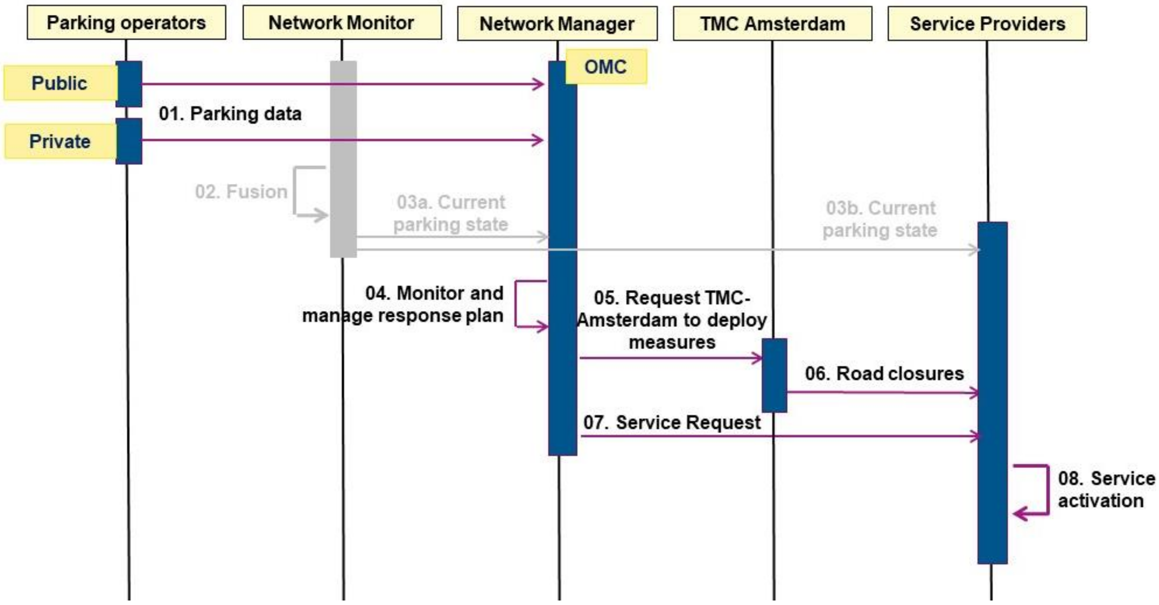


FIGURE 7. SEQUENCE DIAGRAM SMART DESTINATION AMSTERDAM PLATEAU 1

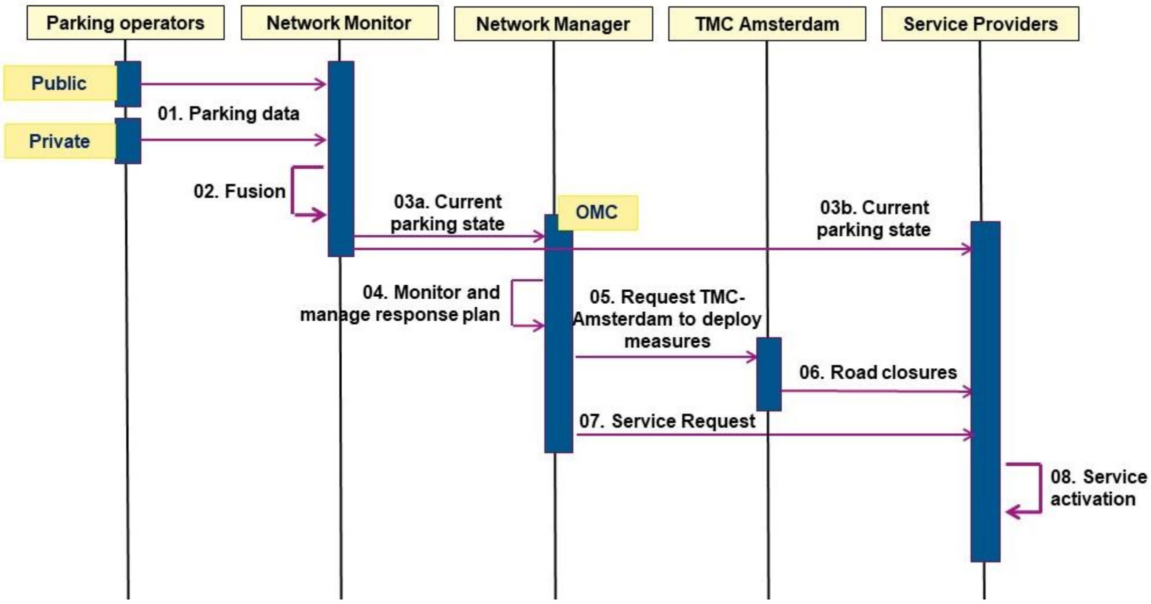


FIGURE 8. SEQUENCE DIAGRAM SMART DESTINATION AMSTERDAM PLATEAU 2

6.2 Processes and interactions

Step 1: Parking Data

In the ArenA Poort Area there are private and public parking operators. Garages of both operators are used for parking during events and therefore parking data of all garages in the area is needed.

The parking data of the public parking locations are published at the open data portal of the City of Amsterdam. Characteristics:

- every minute
- availability of free parking places
- occupancy ratio
- in- and out movers
- based on loops and barrier movements
- SPDP (Standard for Publishing Dynamic Parking Data)
- JSON
- DATEX II
- open data pull (not a pushing platform)

The parking data of the private parking locations differ per private party. At least the data consists of availability and occupancy ratio.

Step 2: Fusion (only plateau 2)

The Network monitor combines the parking data of the public and private parking locations into a current parking state.

Step 3a: Current parking state (only plateau 2)

The current parking state of the parking locations in the area is provided by the Network monitor to the Network manager / OMC. The current parking state consist of the actual available capacity per garage (amount of free parking places). For viewing the web based MobiMaestro of the TMC Amsterdam is used. The parking information is included and processed in the MobiMaestro.

Step 3b: Current parking state (only plateau 2)

The current parking state of the parking locations in the area is provided by the Network monitor to the service providers. The current parking state consist of the actual available capacity per garage (amount of free parking places).

Step 4: Monitor and manage response plans

This task will be carried out by the OMC. Based on the traffic and parking situation and the response plan, the OMC decides on the measures and recommendations. These measures are requested from TMC Amsterdam and the service providers.

The response plans follow a strategy with prioritization of access routes and parking garages for a preferred order in which traffic is led into the area. In order to spread traffic across the area and avoid large flows of crossing traffic, visitors from the East, for example, are guided via the A1 and A9 to parking locations in the southeast of the Amsterdam Arena area.

The OMC uses the web-based version of MobiMaestro of the TMC Amsterdam to implement the measures.

Step 5: Request TMC Amsterdam to deploy measures

Because of the use of the MobiMaestro of the TMC Amsterdam in the OMC, a decision and activation of a measure by the OMC automatically results in a deployment of the measures by the TMC Amsterdam.

Step 6: Road closures

If the decision of the OMC leads to road closures or forbidden directions, the information about these measures is sent to the service providers (in DATEX II). These measures can be used by service providers for their route advice to their users, so the users cannot receive impossible advice through closed roads.

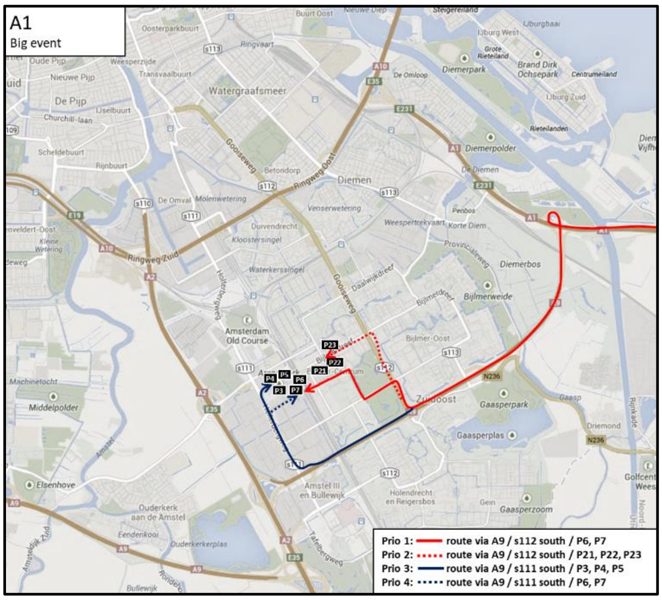
On technical level the information on road closures is sent from the MobiMaesto of Amsterdam to NDW, which in turn makes the information available at an end-point from which the service providers can extract it.

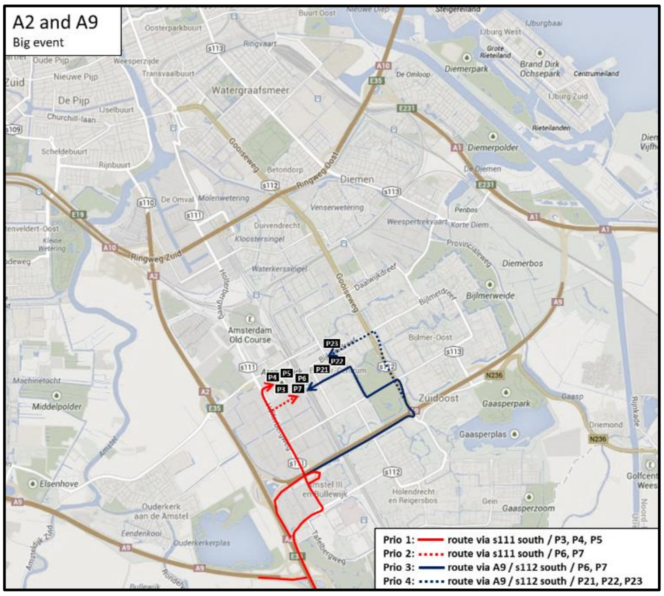
Step 7: Service Request

In its role as network manager, the OMC sends service requests to the service providers.
The service requests are specific routes from the highway to a free parking garage (or group of parking garages). The OMC has insight into the free parking spaces in the event area and will provide a route (according to the strategy in the response plan) to those free parking spaces. The service request supports the traffic management measures in the area deployed by the TMC.

If a parking location is almost full, a new service request is sent, with a route to another parking location. If a route is too busy or closed (in the case of implemented measures by the traffic management centres or an incident), a new service request is also sent.

The following routes will be used for the service request:





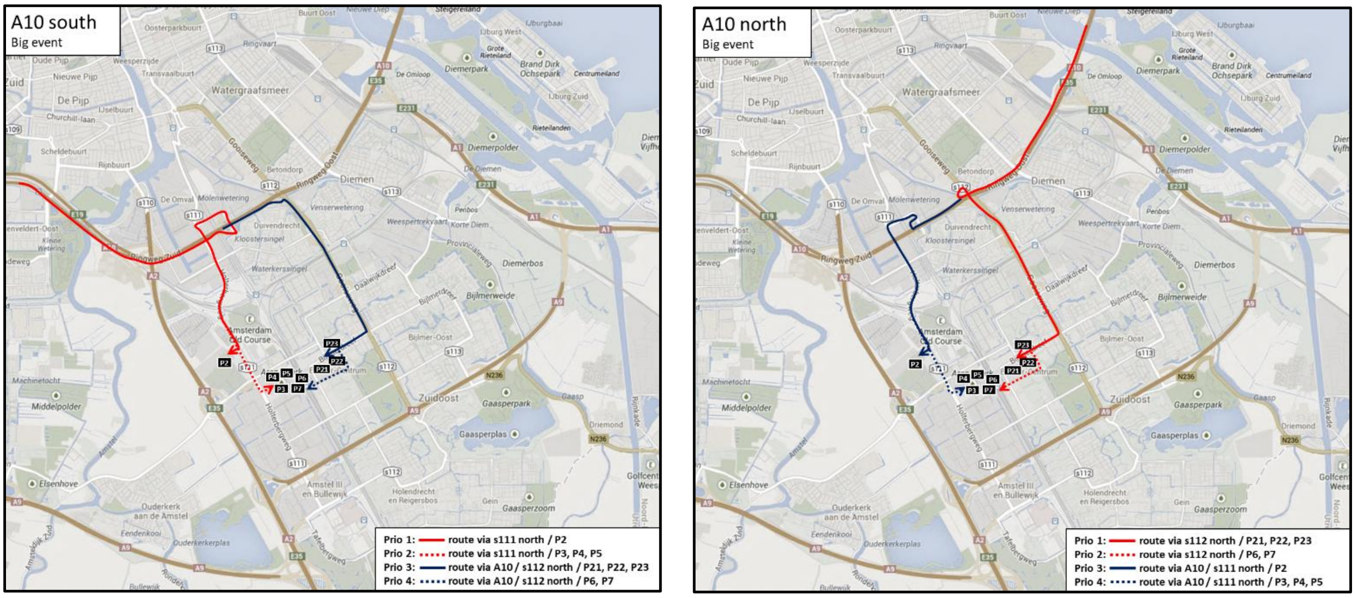


FIGURE 9. STRATEGY PARKING AND ROUTES SMART DESTINATION AMSTERDAM

For each direction a separate route is sent as a service request; starting with the route with priority 1 in the maps above. In case of a full parking location or a busy or closed road, one of the other routes is sent as a service request.

For example, the following map shows the routes that are sent as a service request at the start of an event in the Amsterdam Arena.

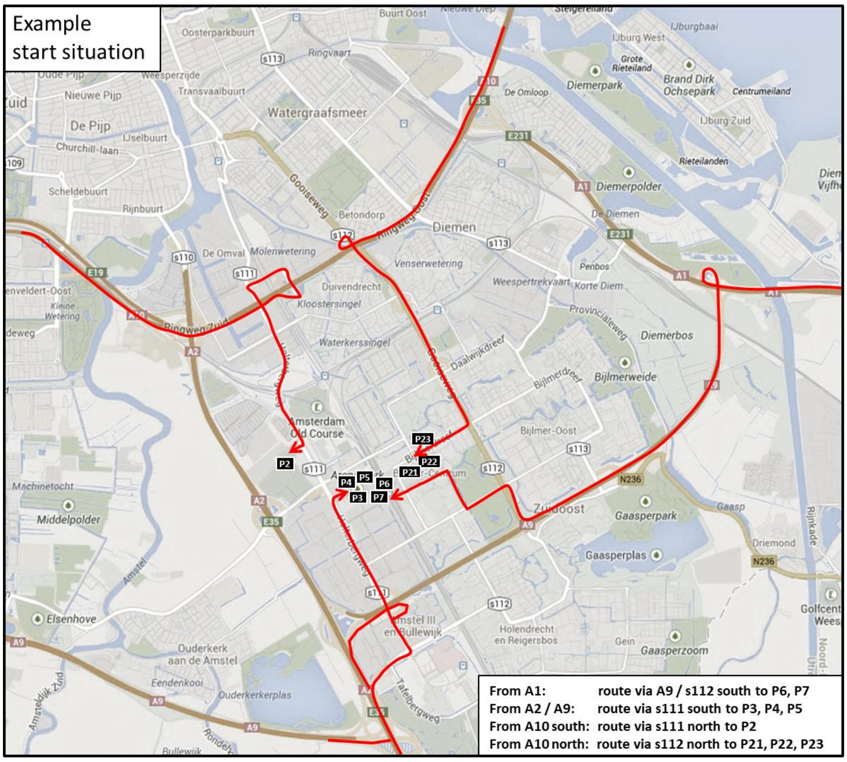


FIGURE 10. EXAMPLE PARKING ROUTES AT START EVENT SMART DESTINATION AMSTERDAM

On technical level the service request is sent from the MobiMaesto of Amsterdam to Technolution, which in turn makes the information available at an end-point from which the service providers can extract it.

Step 8: Service activation

Internal process of service provider.

7. SYSTEM ARCHITECTURE - SD

7.1 System / application overview

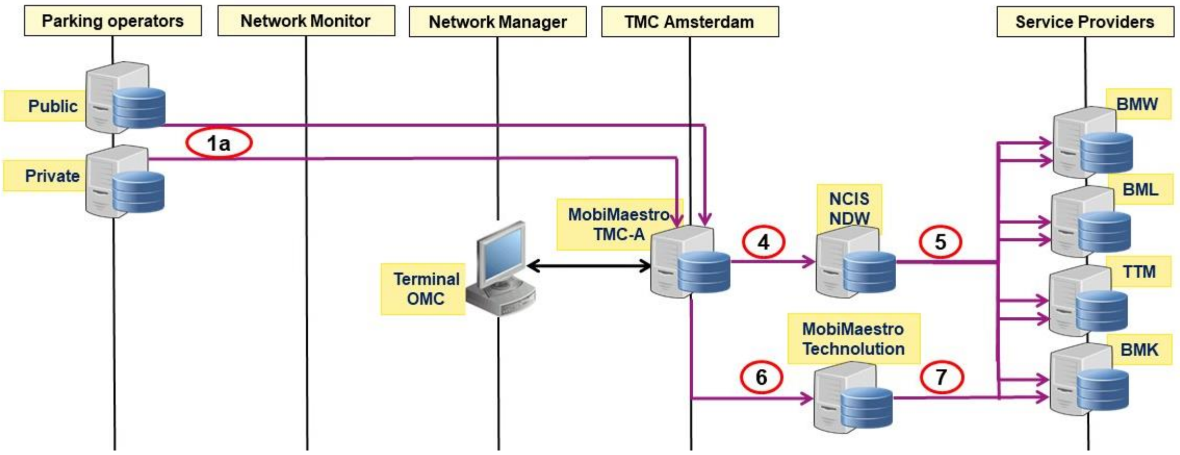


FIGURE 11. SYSTEM OVERVIEW SMART DESTINATION AMSTERDAM PLATEAU 1

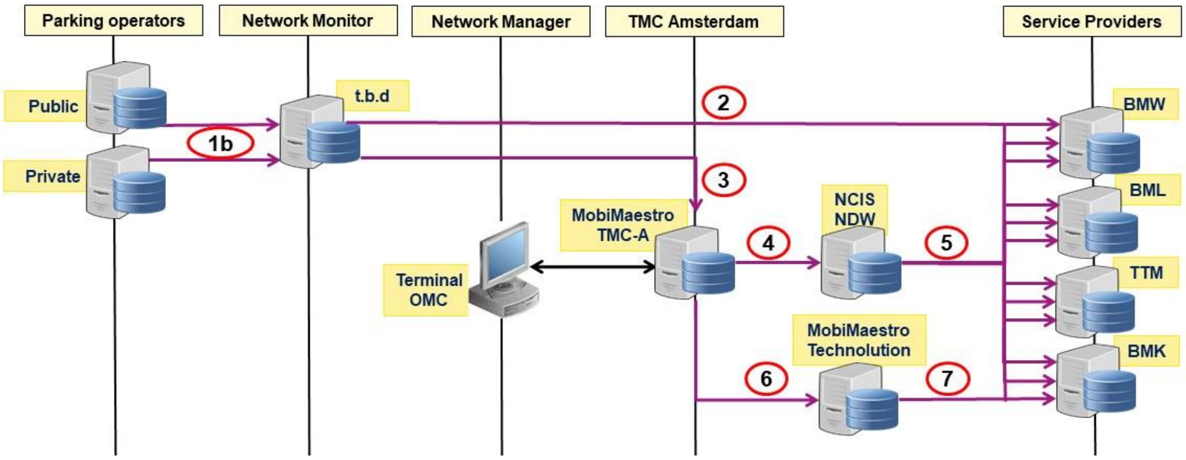


FIGURE 12. SYSTEM OVERVIEW SMART DESTINATION AMSTERDAM PLATEAU 2

7.2 Overview interfaces

An overview of the identified interfaces is shown in the application architecture. In this picture internal (black) and external (purple) interfaces are shown. The internal black interfaces are not described in detail. Partners are responsible for own internal interfaces.

The external purple interfaces are numbered 1 to 7 and are described in the table below.

ID	Partner (system/app)	Information	Status
SD_AMS_1a	Systems Parking Operators – OMC	Original source for the parking information	Existing source Existing interface Existing receiver
SD_AMS_1b (plateau 2)	Systems Parking Operators – Parking platform t.b.d.	Original source for the parking information	Existing source New interface New receiver
SD_ AMS_2 (plateau 2)	Parking platform t.b.d. – Systems service providers	Current parking state in DATEX	New source New interface New receiver
SD_ AMS_3 (plateau 2)	Parking platform t.b.d. – MobiMaestro TMC Amsterdam (OMC)	Current parking state in DATEX	New source New interface Existing receiver
SD_ AMS_4	MobiMaestro TMC Amsterdam – NCIS NDW	Road closures in DVM-X	Existing source Existing interface Existing receiver
SD_ AMS_5	NCIS NDW – Systems service providers	Road closures in DATEX	New source New interface New receiver
SD_AMS_6	MobiMaestro TMC Amsterdam – MobiMaestro Technolution	Request for change of route and parking in DVM-X	New source New interface New receiver
SD_ AMS_7	MobiMaestro Technolution – Systems Service Providers	Publication of service requests (parking and route) in DATEX	New source New interface New receiver

7.3 Interface 7 description (TMex)

Functional top-level information-elements inflow

The provided dynamic information is separated in two functional parts:

Preferred routes to defined parkings in the Arena area.

- preferred routes are independent from the availability of parking places in the parking, but are defined to spread traffic from the different directions over the available network in the area, minimising the chances of junction-locks.
- The preferred route to a parking can change due to traffic conditions.
- preferred routes are provided, depending on the origin (defined by the rerouting decision point (RDP)) and destination (the preferred parking from that origin at a specific moment in time (based on availability)).
- The functional expectation is that those vehicles on their way to the indicated destination, which have not yet passed the RDP are guided in their navigation via the provided preferred route. There is no expectation about marking the RDP with an icon.
- This activation applies only to those vehicles that have not yet passed the decision point at the moment of activation. All vehicles between the decision point and the destination (the original parking) will normally have access to the original parking and can continue their journey as planned.
- The preferred routes are not necessarily the shortest or the fastest route to the parking.

Unavailable parkings

- unavailability can be because the parking is full, or because it cannot be reached due to an incident on the route towards the parking. When a parking becomes unavailable a recommended alternative parking is provided.
- It can happen that different alternatives are provided, depending on the origin of traffic.

- With this the navigation devices can determine whether his destination is still available or he has to switch to the recommended alternative.

Functional top-level information-elements outflow

Once the event comes to an end, the mandatory outflow routes are published. These service requests provide information about original routes that are not available (closed) and a mandatory alternative that needs to be followed until the end of the provided alternative. From here on the navigation can determine the route to the destination of the end user.

Corresponding DATEX II messages

This information is provided in DATEX II situations, with the following functional breakdown in situations and subsequent situation records.

- (Inflow service request) For each origin of traffic a Situation with ID SOC02_PSAxx (with x being the roadnumber + E or S in case of the A10) for the status of the parkings from that origin. These situations are having:
  - One situation record per unavailable parking and its current alternative. The alternative record also holds the origin of traffic.
  - A record is published, once the parking unavailability demands for it.
  - If an alternative gets full:
    - An additional record stating the unavailability of this parking is published (in combination with its alternative)
    - the record of the already full parking(s) is updated with the new alternative.

- (Inflow service request) Per origin a situation with ID Soc02_X (where X is determined by the road name of the decision point where the preferred route to the Arena area starts. So for the A2 X=2, For the A9 X=9 etc.)
  - per route-destination combination a rerouting situation record is maintained, providing the decision point of the alternative route and the destination.
    - The preferred route is provided as alternativeRouteInformation giving the preferred route to get to the destination, starting at the decision point,
    - The decision point is the location of the situationRecord which is of type ReroutingManagement. The destination is in the destination.
    - The complianceOption is set to mandatory, as in this service, it is agreed that the service will comply and not assess himself alternatives.
    - It is not a binding traffic regulation, that would only hold if a competent authority mandates a detour or deviation by an official regulation, which is not the case here.
  - A changing destination because of unavailability of the parking, will result in
    - suspending of the situation record with the active routing
    - activating the situation record with the preferred route to the new destination. The new record will have a cause, which refers to the relevant Parking unavailability records in situation SOC02_0.

- Once the traffic and parking situation allows for it:
  - preferred routing situation records will be ended.

- (Outflow service request) Per Parking a situation with ID Soc02_Pxyz (where xyz is determined by the numbers of the parking to which the service request applies.
  - a rerouting situation record is maintained, providing the decision point for the alternative route. This is by default the exit of the Parking.
  - The originalRouteInformation provides the stretch of road which is not available. If the navigation would normally have routed via this originalRouteInformaiton, it now shall adapt the route to the one provided in alternativeRouteInformation.
  - The preferred route is provided as alternativeRouteInformation giving the preferred route to leave the parking.

- The navigation is supposed to follow the entire alternativeRoute and determine the final route to the destination of the traveller from the last point of the alternative route onwards.
- The decision point is the location of the situationRecord which is of type ReroutingManagement.
- The complianceOption is set to mandatory, as in this service, it is agreed that the service will comply and not assess himself alternatives.
- It is a binding traffic regulation, because a competent authority mandates the detour by an official regulation, supported with authorised traffic controllers.
- The outflow route can change. In that case an update of the involved situationrecord with the modified alternativeRoute and, if applicable the closed originalroute will be published.

– Once the traffic and parking situation allows for it:
    - parking unavailability records will be ended

DATEX II exchange

The provided information is snapshot push. Which means that only records and situations that have been modified are sent. The client needs to maintain the complete overview of the parking status and service requests based on the received information. The server does not offer automated resynchronisation services.

The ending of situationrecords and situations can therefore be recognised by the fact that they are not in the published d2Payload message anymore.

The last message is an empty d2Payload.

Example

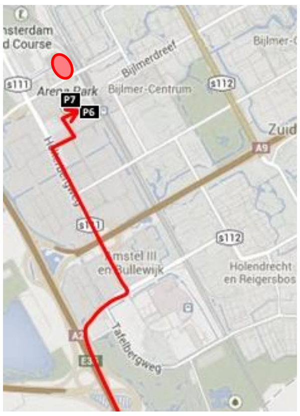
16 December 2019:

- 20:00 Event in the Johan Cruyff Arena starts.
- 22:00 Event ends.

This timeline is about the provided information for traffic coming from the south of Amsterdam via the A2. For the other origins (A1, A9, A10 south and A10 east) the same information is provided simultaneously.

The priority in parkings and routes for the origin A2 is as follows:

1. P3, P4, P5 via s111



2. P6, P7 via s111

3. P6, P7 via s112

4. P21, P22 via s112

The corresponding DATEX II publications are:

16:00: **SOC02_2_1** (A2_Prio1_via_s111_to_P3_P4_P5)

18:14: **SOC02_2_2** (A2_Prio2_via_s111_to_P6_P7)

18:53: **SOC02_2_3** (A2_Prio3_via_s112_to_P6_P7)

19:47: **SOC02_2_4** (A2_Prio4_via_s112_to_P21_P22)

20:15: **SOC02_2 EndOfPreferredRouting**

21:30: **SOC02_P345_1** (Outflow_P3_P4_P5_via_BSW_to_A2)

22:38: **SOC02_P345_2** (Outflow_P3_P4_P5_via_s111_to_A9)

23:53: **SOC02 TerminationOfAll**

Time	What happens	What is published	D2Situation	D2SitRecord	Version
16:00	Start of Smart Destination Plan	Preferred route to P3, P4, P5 activated	SOC02_2	SOC02_2_1	1
18:14	Parking P3, P4, P5 85% full	P3, P4, P5 unavailable, alternative P6, P7	SOC02_PSA2	SOC02_PSA2_1	1
		Preferred route to P3, P4, P5 suspended	SOC02_2	SOC02_2_1	2
		Preferred route to P6, P7 via s111 activated		SOC02_2_2	1
18:53	Route to parking P6, P7 via s111 blocked	P3, P4, P5 unavailable, alternative P6, P7	SOC02_PSA2	SOC02_PSA2_1	1
		Preferred route to P3, P4, P5 suspended	SOC02_2	SOC02_2_1	2
		Preferred route to P6, P7 via s111 suspended		SOC02_2_2	2
		Preferred route to P6, P7 via s112 activated		SOC02_2_3	1
19:47	Parking P6, P7 85% full	P3, P4, P5 unavailable, alternative P21, P22	SOC02_PSA2	SOC02_PSA2_1	2
		P6, P7 unavailable, alternative P21, P22		SOC02_PSA2_2	1
		Preferred route to P3, P4, P5 suspended	SOC02_2	SOC02_2_1	2
		Preferred route to P6, P7 via s111 suspended		SOC02_2_2	2

		Preferred route to P6, P7 via s112 suspended		SOC02_2_3	2
		Preferred route to P21, P22 activated		SOC02_2_4	1
20:15	Event is underway All preferred routes are withdrawn	P3, P4, P5 unavailable, alternative P21, P22	SOC02_PSA2	SOC02_PSA2_1	2
		P6, P7 unavailable, alternative P21, P22		SOC02_PSA2_2	1
21:30	The outflow strategy starts	P3, P4, P5 are directed towards the A2	SOC02_P345	SOC02_P345	1
22:28	Route P3, P4, P5 towards A2 blocked	P3, P4, P5 traffic is directed towards the A9	SOC02_P345	SOC02_P345	2
23:53	All situations are ended	Empty D2Payload			

8. INTRODUCTION - RW

In Activity 3 the functional design of the use case Road Works has been described and finalized. In Activity 4 this functional design is translated in a technical design. Based on this design the pilot is developed.

In this report the technical design is described. After the description of the use case and information architecture, the technical architecture identifies the different system components and describes the interfaces between these components.

8.1 Use case description

The use case Road Works focusses on data quality improvement in the live stream as described and finalised in activity 3 for Road Works use cases. The use case was to be deployed in the following pilot sites;

- Antwerp
- Amsterdam
- Munich

The use case description for all Pilot sites is the same and incorporates a pilot site specific roles, datafeeds and extensions.

The pilot site Amsterdam planned to include a contractor. The partnered Contractor has a (external) contract during the pilot period to perform scheduled and ad-hoc maintenance work within the pilot region. The contractor would share planned and changed road works information in a real-time form with the Intermediair as do the Service Providers and Road Authorities. The contractor would rely his planning information and any updates to the network monitor and in return will receive a full common operational picture for road works.

The pilot site Amsterdam involves three Road Authorities, namely;

- City of Amsterdam
- Province of North-Holland
- Rijkswaterstaat

These RA's are mainly represented and facilitated by NDW.

In all pilot sites the assessor will investigate the quality improvement and establish the value of the full chain and aid in deriving win-win-win's from the lessons learned.

Because of the fact that the 100% RW use case for pilot site Antwerp was already 80% for the Amsterdam and Munich sites, it has been decided to combine the RW use cases for all sites into one effort and resulting document with extensions for Amsterdam and Munich.

8.2 Functional overview (SOLL Act.3 vs. IST Start Act.4 vs. IST End Act.4)

Changes in relation to Activity 3 – functional design

	Activity 3	Activity 4
3.1 System overview	Fusion result distributed as TMeX and JSON	DATEXII not implemented in end result data feed
3.2 Cooperation Model	Shared view	No changes
3.3 Roles	Road Authority, Agregator Public Data provider, Private Service provider, Network Monitor, Contractor	The role of Contractor has not been fulfilled
3.4 Intermediary	MAPtm fulfils the role of intermediary and Tursted Third Party	No changes
3.5 Actors	MAPtm, NDW, HERE, TomTom, Be-mobile, PNH, contractor	No contractor
3.6 Pre/post-conditions	Supplied current data sources will not be provided as-is for use within this use case	No “deltas” nor quality inidicators provided with common picture feed
3.7 Sequence diagram		No significant changes

Staged deployment of functionalities

The operational stage (December ’19 to June ’20) is divided in 2 plateaus.

- The 1st plateau is the period from December 2019 until end March 2020.
- The 2nd plateau is the period from April 2020 until end June 2020. New functionalities are added in plateau 2.

Plateau 1 functionalities:

This plateau featue a first version of data fusion focussing on simple fusioning the data from all sources into a common view where overlapping/same reports are merged into one report.

Plateau 2 functionalities:

Built upon plateau 1, this release encompasis als the interpretation by the intermediary based on the provided data on the subjects of probability, thustwurthiness and detail completeness. All engulving from a successful fusion process, established in plateau 1.

Actual situation End of Operational period (IST End Act.4)

The aimed result from Plateau 1 has been delivered as planned but as a two stage rollout. First rollout saw the incorporation of the data from the private partners. This data has been fetched, stored, combined and slimmed to create a fused set. Incorporation of the data from the Road Authorities had more technical challenge than expected based on the supplied and known characteristics of the data. The sheer amount of data available combined with the characteristics of the data format used for suppling the data has proven difficult to handle. This was overcome by upgrading the available hardware specification on the supplier side and spending more time than planned on implementing the data.

Due to these setbacks, and every pilot site having setbacks (similar or different) the allotted time for realising the set goals within the use case has proven not to be sufficient.

This has been mitigated by focussing on delivering plateau 1. Main reason for this has been that the results of fusion and the match-rate achieved with fusion between sources had not a high rate. Creating the common view including delta's and probality rates would be possible but without a significant number of matches to test and affirm the working of the developed fusion methode.

What has been developed is a proposal for changing/extending DATEX-II with a extra container/element that ensures the insights from the intermediary on delta's, matchrates, data extending, data inserting and probility rates can be included and communicated using the DATEX-II framework.

9. INFORMATION ARCHITECTURE - RW

9.1 Sequence diagram

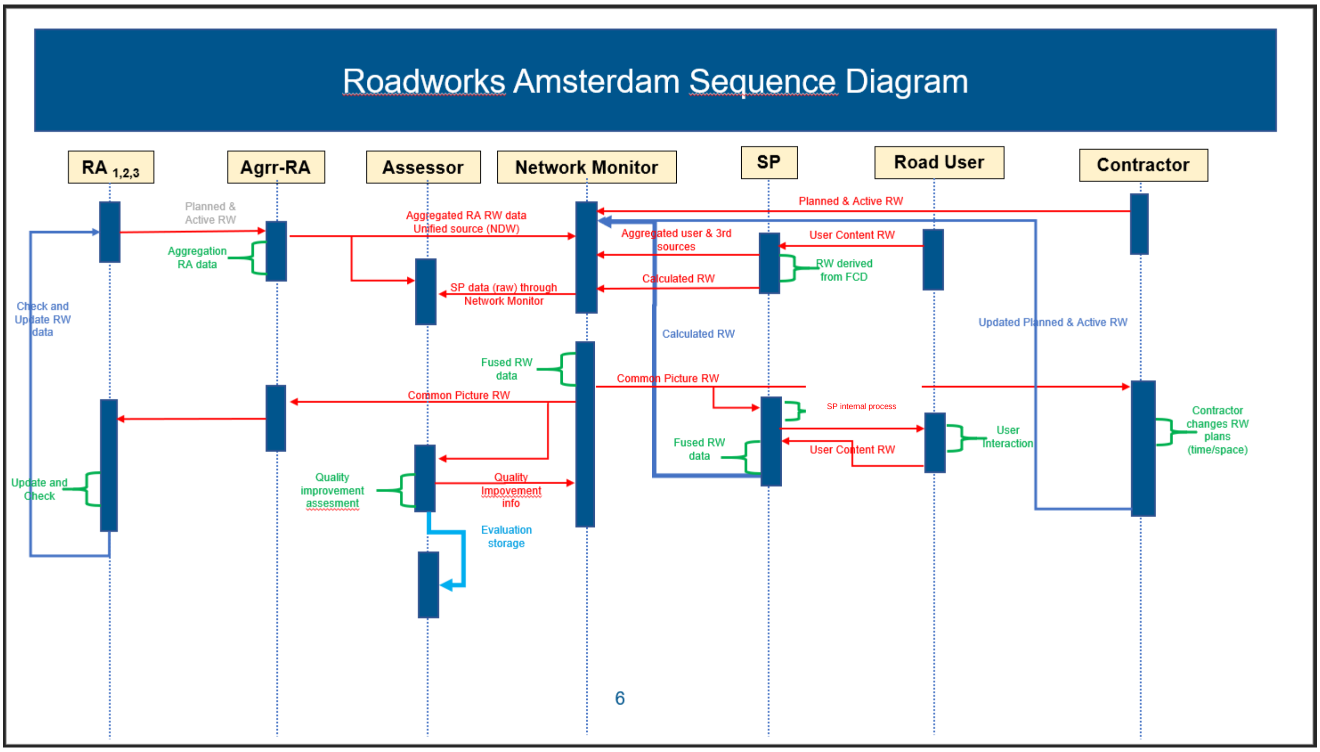


FIGURE 13: SEQUENCE DIAGRAM ROAD WORKS AMSTERDAM

9.2 Partners and User Stories

User stories focus on the experience — what the Actors using the product want to be able to do. User stories should be written in one or two sentences and capture who the user is, what they want, and why.

A simple structure for defining features or user stories can look something like this: As a ____, I want to achieve ____ so that I realize the following benefit of ____.

User stories are used to describe the information architecture in a logic and sequential way. The information architecture (IA) is a textual elaboration of the sequence diagram. It contains

- Actors – entity that is capable of performing behaviour (e.g. companies, institutions).
- Roles – responsibility for performing specific behaviour, to which an actor can be assigned, or the part an actor plays in a particular action or event.
- Services - explicitly defined exposed behaviour
- Processes - sequence of behaviours that achieves a specific outcome.
- Events - behaviour element that denotes a state change
- Interfaces - A point of access where one or more services are exposed to the environment.
- Objects - element (often information or data object) that cannot perform behaviour.

User story from TMC perspectives

Road Operators

Road Authority: Rijkswaterstaat, Province of Noord-Holland and NDW

As a Road Authority, I want to provide actual hindrance of roadworks to the road user.

- *I collect roadworks information from various data sources. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *The information is provided via NDW to a public endpoint. The data is provided in DATEX II format to the intermediary. The message includes information about start time and end time of the roadworks as well as the location of the roadworks. The message can, depending on the local situation, contain additional information on lanes closed/available, roads closed, narrowed lanes, lane diversion, temporary traffic lights, mobile road works, hindrance class, limitations for vehicles with certain characteristics, residual road width, speed restriction, road availability for emergency services during roadworks, rerouting and overrunning*
- *I monitor the network and validate the roadworks information and if possible update the information based on a constant monitoring and measure setting process. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *I detect new roadworks or changes in the existing ones. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$. Based on this I provide updated information to the public endpoint.*
- *NDW receives a common roadworks picture from the intermediary in DATEXII format. This message includes information about the roadworks (location, time and extend/length), the Universal Unique ID for the roadworks, and a confidence level.*
- *I use the common roadwork picture received by though the intermediary to evaluate the quality of own road works information and aim to improve the process for generating Road Works information.*

Identified Interface 1: DATEX II (based on v2.3) between Road Authority – Intermediary (From RA to Intermediary only)

- Objects exchanged: *Either the "wegwerkzaamheden" feed of NDW or the "actuele statusberichten" feed of NDW.*
  The "wegwerkzaamheden" feed is both planned and actual Roadworks. The two types can be distinguished by status. The "actuele statusberichten" feed contains all current situational messages active on the road, including actual roadworks which can be distinguished if wanted.

  - *Situation record creation time*
  - *Situation record version*
  - *Situation record version time*
  - *Probability of occurrence*
  - *Validity status*
  - *Overall start date*
  - *Overall end date*
  - *Period start date (if applicable)*
  - *Period end date (if applicable)*
  - *location by coordinates*
  - *location by Linear Referencing (if available)*
  - *Network Management type (+ subtype)*

- *lanes closed/available*
- *mobile road works if applicable*
- *roads closed if applicable*
- *narrow lanes if applicable*
- *temporary traffic lights if applicable*
- *lane diversion if applicable*
- *hindrance class*
- *limitations for vehicles with certain characteristics*
- *residual road width if applicable*
- *speed restriction if applicable*
- *road availability for emergency services during roadworks*
- *rerouting*
- *overrunning if applicable*

Identified Interface 2: DATEX II (based on v2.3) between Intermediary - Road Authority (From Intermediary to RA only)

- Objects exchanged:
  - *Location OpenLR*
  - *Location as WGS84*
  - *Start datetime for RW*
  - *End datetime for RW*
  - *UUID (for when only a delta is provided from Network Monitor)*
  - *Situational record version*
  - *Probability of occurrence (confidentiality)*
  - *Validity status*
  - *Type of Roadworks*

User story from SP perspectives

Be-Mobile

Service provider: Be-Mobile

As a Service provider, I want to provide most accurate real time information on roadworks to my users, so that they experience a satisfying journey.

- *I collect roadworks information from various data sources. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *I monitor the network and validate the roadworks information based on additional data sources. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *I detect new roadworks or changes in the existing ones. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *Roadworks information are part of the incident feed that we provide to our customers through an API. The data is provided in JSON format to the intermediary. The message includes information about start time and end time of the measure as well as the location of the roadworks*
- *I receive a common roadworks picture from the intermediary in DATEXII format. This message includes information about the roadworks, the trackable ID for the roadworks, and a confidence level.*

- *I validate internally against my information the common roadwork picture and, if necessary, update my information and/or algorithms.*

Identified Interface: **JSON** between Be-Mobile – Intermediary
Objects exchanged:

- Author (Be-Mobile)
- Country (Belgium, Netherlands)
- Event_ID
- Source (Flemish TMC, TouringMobilis, Waze, Police, …) & source_ID
- Version (new version when features of traffic event change, e.g. extra lane closed).
- Alert C code (description of traffic event)
- Freetext (textual description of traffic event)
- Heading (direction of traffic event)
- Location TMC
- Location Wgs84
- Location Wkt
- Location Geojson
- Starttime (YYMMDDHHMMSSZ (UTC))
- Endtime (YYMMDDHHMMSSZ (UTC))

TomTom

Service provider: TomTom

As a Service provider, I want to provide most accurate real time information on roadworks to my users, so that they experience a satisfying journey.

- *I collect roadworks information from various data sources. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *I monitor the network and validate the roadworks information based on additional data sources. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *I detect new roadworks or changes in the existing ones. This is an existing service, nothing new needs to be developed for SOCRATES$^{2.0}$.*
- *Roadworks information are part of the incident feed that we provide to our customers through an API. The data is provided in DATEXII format to the intermediary. The message includes information about start time and end time of the measure as well as the location of the roadworks*
- *I receive a common roadworks picture from the intermediary in DATEXII format. This message includes information about the roadworks, the trackable ID for the roadworks, and a confidence level.*
- *I validate internally against my information the common roadwork picture and if necessary update my information and/or algorithms.*

Identified Interface: **JSON** between TomTom– Intermediary
Objects exchanged:

- Situational record creation time
- Situational record version
- Situational record first supplier version time
- Probability of occurrence
- Validity status

- Overall start date
- location OpenLR or WGS84
- Network Management type

User story from Intermediary perspectives

Network Monitor

<u>Intermediary: MAPtm</u>

As an Intermediary, I want to provide most accurate real time information on roadworks to the Service providers and road authorities by fusing their data, so that they can provide the most accurate data to their end systems.

- *I collect roadworks information from various parties. This is an existing service for road authorities, and a new service for Service Providers.*
- *I monitor the data and fuse data where needed and/or extend the data sets.*
- *I detect newly reported Road Works and add them to the data set with a new UUID.*
- *Based on input from service providers I add a probability for the Road Works information.*
- *I produce a Common Road Works Picture which is provided to Service Providers and Road Authorities and the Assessor.*

Identified Interface: **TMeX** between Intermediary – Use Case partners

Format of interface supplied is either JSON or XML. By choice of partners

Objects exchanged:

- Location of event (openLR & WGS84)
- Unique Event_ID
- Version (new version when features of traffic event change, e.g. extra lane closed).
- description of traffic event
- Freetext (textual description of traffic event)
- Heading (direction of traffic event)
- Location Wgs84
- Starttime (YYMMDDHHMMSSZ (UTC))
- Endtime (YYMMDDHHMMSSZ (UTC))
- Probability
- Number of sources reporting event
- Detection method (Manual, System, User Input)
- Quality Index

Assessor

Intermediary: MAPtm

The assessor shall determine the rate of quality improvement based on the delivered data per SP and RA and the fused result. Assessment shall be done based on data completeness, timeliness and probability rate. For this the user feedback loop will be used where possible.

10. SYSTEM ARCHITECTURE - RW

10.1 System overview

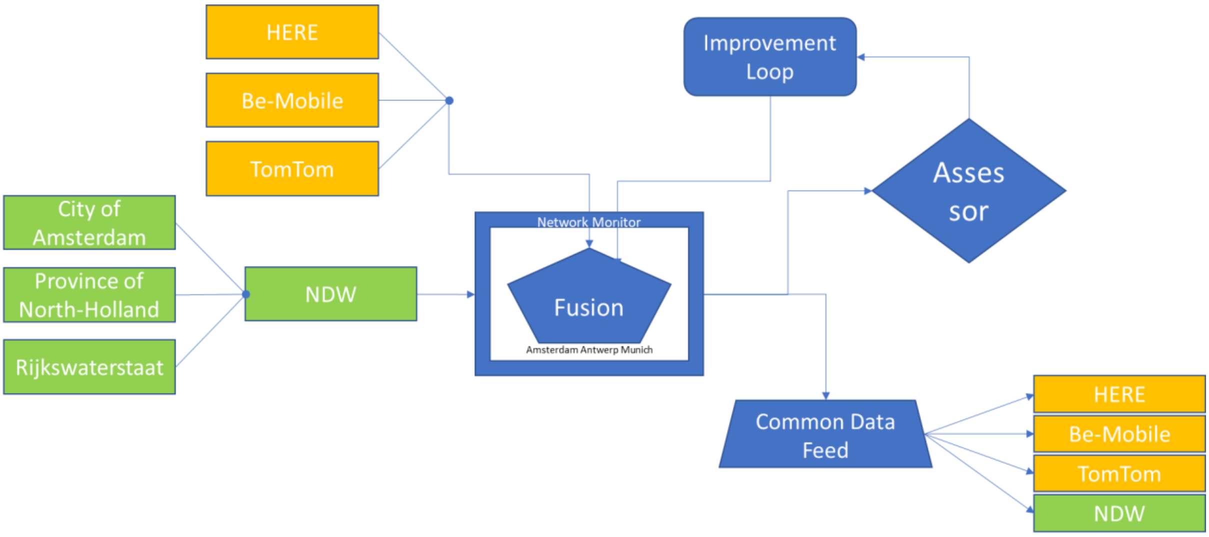


FIGURE 14: SYSTEM OVERVIEW ROADWORKS AMSTERDAM

10.2 Interface descriptions

Interface **ALLSITES-RW-CM3:**

Information can be pulled

Objects to be included (technical description):

Scope	name	INT1	INT2	type	definition	requirement	comment
Space	location OpenLR	x	x	openLR		Need	Optional
	location WGS84	x		POINT(x,y,z)		Optional	Optional
Time	Situational record creation time	x	x	DATETIME	versioning		
	Planned Start datetime for RW	x	x	DATETIME	Start time of Road works	evalution storage	Changes logging in boekhouding IM situationRecordFirstSupplierVersionTime
	Actual start datetime for RW		x		Reported Start time	evalution storage	Changes logging in boekhouding IM situationRecordVersionTime
	Detected datetime for RW		x		This is NOT a start time	evalution storage	Changes logging in boekhouding IM situationRecordObservationTime
					versioning is needed		
Meta	Situational record version	x	x	VARCHAR			
	Network Management type	x	x	VARCHAR	?	copy from datexII?	
	Situational record first supplier version time	x	x	VARCHAR	?	copy from datexII?	
	Probability of occurrence		x	INT		already available	certain/probable/riskOf certain is definitief (change van starttime)
	Probability rate		x	INT		Combine with probalitiy? Define the field!	Added to profile
	UUID		x	UUID	Unique ID	Traceability	
	Type of Roadworks		x	TEXT or INT	moving, stationary, long-term		
	lanes closed/available	x		TEXT or INT	status of lane availability	0 = open, 1 = closed, sequence number for lane postition on road	>Groupoflocation boom of > impact
	Narrow Lanes	x		TEXT or INT	lanes wit reduced width	optional	> OperatorActions - RoadorCarriageWaytManagement
	Reduced speed					Do we need this? Can we get this from a different datexII container for this location?	SpeedManagement
	one lane traffic control	x		TEXT or INT	Temporary Traffic Light Signals in use or Traffic Warden	TLC for controlling one lane traffic	GeneralNetworkManagement > trafficManuallyDirectedBy
	Counterflow traffic	x		TEXT or INT	Traffic is divert to the other side of the road		alternating traffic over one lane
	Detour information					Copy from input. Avaliable in antwerp/munich?	ReRoutingManagement (in NL verplicht om andere route op te geven als gebruikt wordt)
	Passable for emercency services						RoadOrCarriageManagement > useOfSpecifiedLanesAllowed (wegafgesloten voor alles behalve) (validity aangeven met period)
	Changed Traffic Situation	x		?	Road Layout has changed	for changes in longer term RW	
	Author	x		TEKST or INT	Alert created by	dependable on whether this is allowed	Source

Scope	name	INT1	INT2	type	definition	requirement	comment
Space	location OpenLR	x	x	openLR		Need	Optional
	location WGS84	x		POINT(x,y,z)		Optional	Optional
Time	Situational record creation time	x	x	DATETIME	versioning		
	Planned Start datetime for RW	x	x	DATETIME	Start time of Road works	evalution storage	Changes logging in boekhouding IM situationRecordFirstSupplierVersionTime
	Actual start datetime for RW		x		Reported Start time	evalution storage	Changes logging in boekhouding IM situationRecordVersionTime
	Detected datetime for RW		x		This is NOT a start time	evalution storage	Changes logging in boekhouding IM situationRecordObservationTime
					versioning is needed		
Meta	Situational record version	x	x	VARCHAR			
	Network Management type	x	x	VARCHAR	?	copy from datexII?	
	Situational record first supplier version time	x	x	VARCHAR	?	copy from datexII?	
	Probability of occurrence		x	INT		already available	certain/probable/riskOf certain is definitief (change van starttime)
	Probability rate		x	INT		Combine with probalitiy? Define the field!	Added to profile
	UUID		x	UUID	Unique ID	Traceability	
	Type of Roadworks		x	TEXT or INT	moving, stationary, long-term		
	lanes closed/available	x		TEXT or INT	status of lane availability	0 = open, 1 = closed, sequence number for lane postition on road	>Groupoflocation boom of > impact
	Narrow Lanes	x		TEXT or INT	lanes wit reduced width	optional	> OperatorActions - RoadorCarriageWaytManagement
	Reduced speed					Do we need this? Can we get this from a different datexII container for this location?	SpeedManagement
	one lane traffic control	x		TEXT or INT	Temporary Traffic Light Signals in use or Traffic Warden	TLC for controlling one lane traffic	GeneralNetworkManagement > trafficManuallyDirectedBy
	Counterflow traffic	x		TEXT or INT	Traffic is divert to the other side of the road		alternating traffic over one lane
	Detour information					Copy from input. Avaliable in antwerp/munich?	ReRoutingManagement (in NL verplicht om andere route op te geven als gebruikt wordt)
	Passable for emercency services						RoadOrCarriageManagement > useOfSpecifiedLanesAllowed (wegafgesloten voor alles behalve) (validity aangeven met period)
	Changed Traffic Situation	x		?	Road Layout has changed	for changes in longer term RW	
	Author	x		TEKST or INT	Alert created by	dependable on whether this is allowed	Source

10.3 RW Message sample

Road Works endpoints

For all pilot sites (Amsterdam, Antwerp, Munich) the Road Works URL-endpoints are formatted in a unified structure;

https://roadworks.maptm.nl/{*pilotsite*}/{*responseformat*}/

The variables within the URL are:

PILOTSITE: This can either be; Amsterdam, Antwerp, Munich

RESPONSEFORMAT: This can either be; TMEX or JSON.

TMEX (XML for DATEXII v2.3)

No valid example available at time of writing.

Road Works data identified in the fusion process to not be within the provided RA DATEX-II feed will be injected into the existing and supplied DATEX-II feed and rebroadcasted with an extra container for added information from the SOCRATES$^{2.0}$ project. Original and updated/added information will co-exist in this feed.

JSON Format

[

```
    {
        "s20_tmexid": 136514,
        "s20_creationtime": "2019-12-17T18:30Z",
        "s20_updatetime": "2019-12-17T18:30Z",
        "s20_endtime": null,
        "s20_version": 1,
        "s20_isactual": true,
        "roadname": "Camera Obscuralaan",
        "locationdescription": "Camera Obscuralaan",
        "directiondiscription": "Construction work:Camera Obscuralaan, between Klaasje Zeve
nsterstraat and Oranjebaan",
        "impactdelay": null,
        "location_wgs84": "LINESTRING(4.87716 52.303272,4.876755 52.302063)",
        "location_fordisplay": "POINT(4.87716 52.303272)",
        "alertccountrycode": null,
        "alertctableid": null,
        "alertcttrafficcode0": null,
        "alertcdescription0": null,
        "alertcduration0": null,
        "alertcdirection0": null,
        "alertcttrafficcode1": null,
        "alertcdescription1": null,
        "alertcduration1": null,
        "alertcdirection1": null,
        "planned_startdatetime_rw": "2019-12-17T18:14Z",
        "actual_startdatetime_rw": null,
        "detected_datetime_rw": null,
        "situationalrecordversion": null,
        "generalnetworkmanagementtype": null,
        "situationalrecordfirstsuppliertime": null,
        "number_ofoccurences": null,
        "probability_ofoccurences": "Probable  ",
        "probability_rate": null,
        "type_ofroadworks": "CONSTRUCTION",
        "numberoflanesrestricted": null,
        "numberofoperationallanes": null,
        "originalnumberoflanes": null,
        "roadclosed": false,
```

```
            "temporaryspeedlimit": null,
            "onelanetrafficcontrol": null,
            "counterflowtraffic": null,
            "detourinformation": null,
            "passableforemercencyservices": null,
            "changedtrafficsituation": null,
            "author": "Socrates  "
        },
        {
            .....
        }
]
```

10.4 Processing the data

Every data feed of the partners was aligned with dataset (TMex) for the Road Works that was agreed upon and where useful information was added if one of the partners data feed had specific useful information. Table 1 shows the contents of the RW-TMex message. As the table shows the list of fields is rather straight forward without nesting information in (sub)containers. Many data fields are already available in varying degrees within the data feeds provided as sources for this use case.

TABLE 1 TMEX MESSAGE SET

Response field	Name	Type	definition	Comment
s20_tmexid		VARCHAR	Socrates 20 uuid	
s20_creationtime		Integer	First creation time	Within framework
s20_updatetime		timestamp	Last update time	Within framework
s20_endtime		timestamp	Detected end time	Within framework
s20_version		timestamp	Version of message	Within framework
s20_isactual		boolean	Message is current	
roadname		VARCHAR	Streetname	
locationdescription		VARCHAR	descriptive text for location information	
directiondiscription		VARCHAR	orientation of RW	
impactdelay		Integer	Time lost due to RW	best guess value
-	*location OpenLR*	*openLR*		
location_wgs84	location WGS84	Linestring		
location_fordisplay	location for display (WGS84)	POINT		
alertccountrycode	from alertC when available	VARCHAR		
alertctableid	from alertC when available	Integer		
alertcttrafficcode0	from alertC when available	Integer		
alertcdescription0	from alertC when available	VARCHAR		
alertcduration0	from alertC when available	VARCHAR		
alertcdirection0	from alertC when available	VARCHAR		
alertcttrafficcode1	from alertC when available	Integer		
alertcdescription1	from alertC when available	VARCHAR		
alertcduration1	from alertC when available	VARCHAR		
alertcdirection1	from alertC when available	VARCHAR		
planned_startdatetime_rw	Planned Start datetime RW	timestamp	Start time of Road works	
actual_startdatetime_rw	Actual start datetime RW	timestamp	Reported Start time	
detected_datetime_rw	Detected datetime RW	timestamp	This is NOT a start time	
situationalrecordversion	Situational record version	Integer		
generalnetworkmanagementtype	Network Management type	VARCHAR		

situationalrecordfirstsupplieriertime	Situational record first supplier version time	VARCHAR		
number_ofoccurences	Number of data suppliers reporting the same RW	Integer	Number of sources reporting some RW	
probability_ofoccurences	Probability of occurrence	VARCHAR	rate for RW are to be seen on the road	
probability_rate	Probability rate	REAL	rate for trueness of RW info	
type_ofroadworks	Type of Roadworks	VARCHAR	moving, stationary, long-term	
numberoflanesrestricted	lanes closed/available	Integer	status of lane availability	When available
numberofoperationallanes	Number lanes opened for traffic during RW	Integer	Number of lanes available	When available
originalnumberoflanes	Number of lanes opened for traffic during normal operation	Integer	Number of lanes available in normal situation	
not available currently, planned for future incorporation	Narrow Lanes	TEXT or INT	lanes wit reduced width	
roadclosed		boolean	Road closed due to road works	
temporaryspeedlimit	Reduced speed	Integer		
onelanetrafficcontrol	one lane traffic control	boolean	Temporary Traffic Light Signals in use or Traffic Warden	
counterflowtraffic	Counterflow traffic	boolean	Traffic is divert to the other side of the road	
detourinformation	Detour information	VARCHAR		
passableforemercencyservices	Passable for emercency services	boolean		
changedtrafficsituation	Changed Traffic Situation	VARCHAR	Road Layout has changed	
author	Author	VARCHAR	Alert created by	

Data harmonisation

During the matching stage of de data feeds of the partners towards the TMex message set, it was striking how much the shape and the contents differed per feed, provider and even between sites(e.g DATEX-II). So, for every feed for every site the code to retrieve and convert to the SOCRATES$^{2.0}$ dataset (TMex) was rewritten and adapted. Feeds differ in complexity, from a compact and straightforward dataset with actual road works to complex DATEX-II data sets including not only actual roadworks but also planned or even past events. Moreover, the naming and coding (e.g. containers or not) of the fields differs per feed. This is also regarding TMC and DATEX-II standardised fields as well.

Differences in georeferencing

- TMC is not harmonic over all sites. The implementation of the TMC principle divers per site/country and thus has had its particularities per site.
- Documentation for TMC is only available for paying members of TISA. Beyond that a current TMC table must be retrieved from the relevant governing bodies and isn't available as open data everywhere. Though, payment is never required for obtaining the TMC tables.
- Service Providers use different geospatial projections. But in most cases provided alternative projections within the feed.
- The Flanders data feed is provided with only TMC as geospatial reference.
- Relying solely on TMC geospatial referencing limits the area where RW can be reported as TMC is not covering all roads (e.g. local and residential roads). This difference is especially visible between Public and Private sources.

Differences in data provision

- DATEX-II has proven not harmonic over all sites

- Detail information is not consistent added
- Update intervals are not always clear and never in sync.
- DATEX-II feed from NDW was to large for a stable feed. To get a good performance Extra RAM memory was allocated on the NDW side and we used a cut out from the region of Amsterdam.

10.5 Common roadworks picture

Timing information

The timing information differs between the data feeds. Some providers broadcast roadworks which are actual. But NDW for instance broadcasts, running and planned. One source gives status actual and end time.

MDM broadcasts multiple datetime fields. To see if a roadwork is actual the fields startofperiod and endofperiod were used.

Geospatial information

All the feeds define a startpoint/location for display. Some combine this with a line string (for instance MDM) and/or an endpoint. TMC gives start- and endpoint, no line string but offset distances to be calculated based on a map matching procedure and requires knowledge of the used TMC implementation and possession of the relevant TMC tables. Same goes for NDW and one of the private providers.

When looking at the TMC point information, some points where not available in the basis information of the TMC points table. This is probably due to having possession of TMC3.1 while the broadcasted information is version 3.3.

Having said that, a known issue when plotting data to any map is the differences between maps, differences between how geo information is written down (X/Y, TMC, Alert-C, VILD) and differences in how geo information is projected on a map altogether. Differences in projection occur due to the fact that the earth is a sphere and it is near impossible to correctly plot any point on that sphere on a flat representation of the sphere. The most common projection is the Mercator projection, invented by Flemish cartographer and geographer, Gerardus Mercator. As an example Flemish point data has been provided in a different project within this project. Just indicating how divers this data spectrum can be. Figure 5 illustrates this.

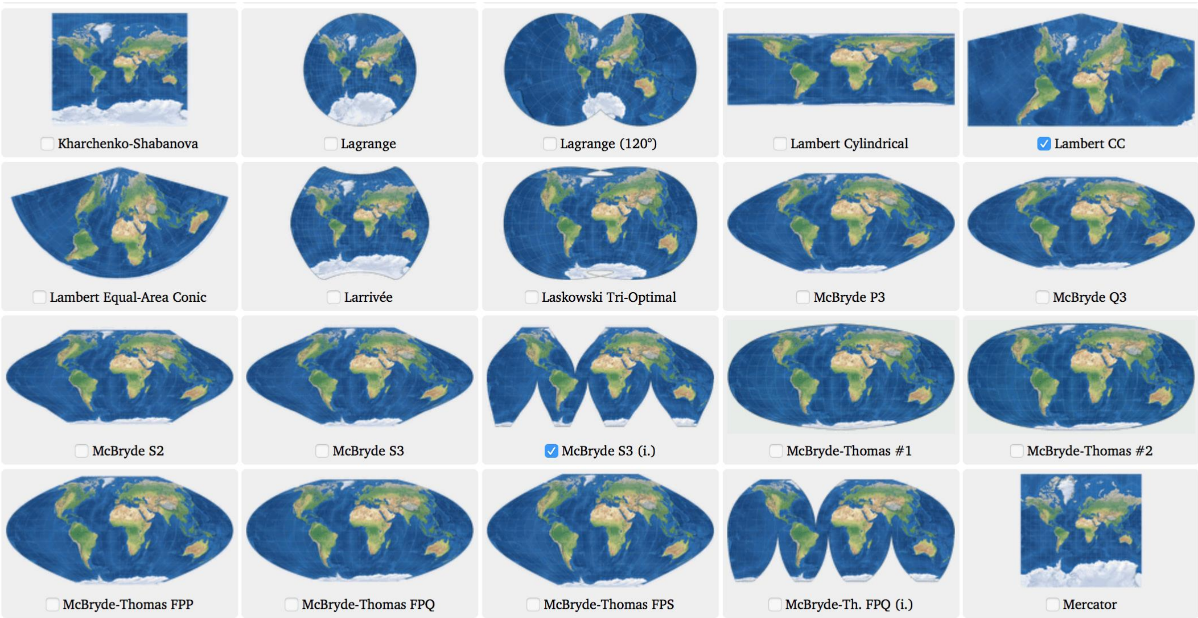


FIGURE 15: AN INCOMPLETE LIST OF TYPES OF MAP PROJECTIONS

For this purpose, all provided geo data had to be translated to a common projection in order to be able to find matches l.

For a first analyses the startpoint/location for display was used for geographical referencing.

11. INTRODUCTION - EZ

In Activity 3 the functional design of the use case Environmental Zone has been described and approved by the SOCRATES2.0 Steering Group in October 2018. In Activity 4 this functional design is elaborated in multiple more detailed designs. Based on this latter design the pilot is developed.

11.1 Use Case description

Prohibited vehicles

Trucks (vehicle category N2 and N3) that have a diesel engine and are heavier than 3.500 kg and have a euro 3 norm or lower. This means trucks with euro 0, 1, 2 or 3 diesel engines are not allowed. Some special vehicles (like vehicles for exceptional transport, crane trucks, concrete mixers / concrete mixers and fire engines) are allowed if they not older than 13 years. Buses and coaches, with the exception of scheduled bus services, are also prohibited in the environmental zone.

Static and dynamic Environmental Zone

The static Environmental Zone is shown on the map below. Around 60 days per year trucks and others are allowed in a part of the environmental zone (via the Kennedylaan), because the standard route is not suitable at that moment. This is because of severe traffic delays towards and from the highway and/or a high amount of trucks during the start and end of events in the RAI area. In most cases the dynamic exemptions duration is several days. This is due to building up events in the RAI venue. In other cases the duration is 1 to 2 hours due to severe congestion.

FIGURE 16. GEOGRAPHICAL OVERVIEW ENVIRONMENTAL ZONE AMSTERDAM

Problem to solve in this use case

Many road users don't know there is an environmental zone before they see a sign. Or they don't know in advance that their route is through an environmental zone. In addition, it is not clear to everyone what requirements apply and whether their vehicle can enter the zone. With the result: vehicles with Dutch number plates are fined, which leads to unhappy travellers and vehicles with non-Dutch number plates are not recognized and not fined, which leads to unfair penalizing and ignoring of the environmental zone.

For the dynamic zone the communication about the availability of the route is complicated; not for everyone this prism sign is clear. This leads to little use of the road, which does not help to reduce the delay on the standard route.

Use case mission

The mission of the use case is to provide better information for truck and coach drivers.

- Static information about the existence and limitations of the environmental zone and;
- Dynamic information about the status of the dynamic zone (on or off).

By means of execution and validation of this use case, it contributes to the overall goals of SOCRATES$^{2.0}$:

- Testing of public private cooperation and new business models;
- Testing of effectiveness of Traffic Management 2.0 – sharing of data)

11.2 Functional overview (SOLL Act.3 vs. IST Start Act.4 vs. IST End Act.4)

Changes in relation to Activity 3 – functional design

Activity 3: Part 3: SOCRATES$^{2.0}$ services for PS-UC

	Activity 3	Activity 4
3.1 System overview		No changes
3.2 Cooperation Model	'Data exchange'	It's a simple 'Shared view', because there is a central trusted intermediary Network Monitor. However, for this use case data is gathered from only 1 data provider (Amsterdam). Furthermore, there is no Assessor. Change is only semantic.
3.3 Roles		No changes
3.4 Intermediary		No changes
3.5 Actors	Be-Mobile, TomTom, BMW and HERE are service providers. Municipality of Amsterdam is data supplier.	Not disclosed
3.6 Pre/post-conditions		No Changes
3.7 Sequence diagram		No Changes

Staged deployment of functionalities

The operational stage (Sept '19 to June '20) is divided in 2 plateaus.

- The 1st plateau is the period from September 2019 until end January 2020.
    - 1st week of October: 'Company users' test
    - 2nd and 3rd week of October: 'Friendly users' test
    - 4th week of October (until end of June) and later: 'SOCRATES2.0 users' recruitment

- The 2nd plateau is the period from February 2020 until end June 2020. New functionalities are added in plateau 2.

Plateau 1 functionalities:

- Using the static DATEX II **RAZ profile**. (à NDW).
- Including improved polygons (à AMS + NDW)
- Profile is sent via email.
- End user service that contains static information; this is **'informing only'** end service. (à SP)

Plateau 2 functionalities:

- the **dynamic information** (Kennedylaan) is added. This dynamic info will be shared in the RAZ profile. (à AMS / NDW).
- Profile is shared via NDW official portal.
- making the service more **user friendly** by adding the navigation option and/or personal preferences, etc. (à SP)
- (option) the additional **other static information** to the RAZ profile (e.g. include bridge heights and allowed tonnage).

Actual situation End of Operational period (IST End Act.4)

Except one, all functionalities were implemented following the activity 4 design. The 'dynamic information' function was only implemented by TomTom. Because of technical challenges, Be-Mobile decided only to implement the static part. Also the approach towards the 'dynamic information' changed during activity 4. In this new approach two static messages alter depending on the status of the dynamic route. Unfortunately, because of Covid-19, there were no events in the RAI event area, and therefore the dynamic route was not activated.

Furthermore, during the operational period the static information was updated due to the enlargement of the Amsterdam environmental zone.

11.3 Active partners and User Stories

Four SOCRATES2.0 partners are active in the Environmental Zone use case Amsterdam.

Partner	Role in use case
City of Amsterdam	Data provider / Road Authority
NDW	Network Monitor
TomTom	End user Service provider
Be-Mobile	End user Service provider

User stories focus on what the partners want to be able to do. User stories should be written in one or two sentences and capture who the user is, what they want, and why. A simple structure for defining features or user stories can look something like this: As a ____, I want to achieve ____ so that I realize the following benefit of ____.

City of Amsterdam – Role Data provider / Road Authority

The city of Amsterdam wants to be a good host for inhabitants and visitors alike. As a public data provider and road authority I want to provide reliable data about our environmental zones to road users. I want to achieve less environmental zone violations and an increase in usage for the dynamic part when the zone is deactivated. Above all, the use case should contribute to improve the air quality.

NDW – Network Monitor

As the national data access point in the Netherlands, I receive environmental zone data from multiple Dutch cities. In this case only from Amsterdam. Thereafter I enrich the data flow and make this information public available in standard European formats. I want to improve the availability, quality and accessibility of public data.

Be-Mobile / TomTom – End user Service provider

As a Service provider, I want to receive up-to-date and accurate data on environmental zones in standard formats. I want to provide most accurate information on environmental zones to my users, so that they experience a satisfying journey.

11.4 Generic description of end user services

End user service level 1: "Informing only"

The service is to inform road users (in this case drivers of trucks, buses and coaches) who have planned a destination in the Environmental Zone or users who have a route through the environmental zone. These users are informed about the environmental zone with information on the geographical limitations (using a geofence). This service does not use the navigation function or vehicle specifications. So, the user doesn't receive an updated route advice in case of driving through the Environmental Zone. However, changes on the Environmental Zone itself is included in this End user service. The latter is not intended during the pilot execution phase.

- ✓ Plateau 1 functionality

End user service level 2: "Navigation function added"

Inform road users (trucks, buses/coaches) if their destination is in or their route is through an environmental zone. Informing about the existence and limitations of the (static) environmental zone with an option to avoid the zone. In case the dynamic environmental zone near the RAI Convention Centre is turned off, a route through that zone will be possible and presented if quicker.

- ✓ Plateau 2 functionality

End user service level 3: "User/vehicle preferences added"

Information is only presented if the zone is applicable for user's vehicle. A user interaction in advance about the type of vehicle is required for this. Information is only presented if the zone is applicable for user's vehicle. A user interaction in advance about the type of vehicle is required for this.

- ✓ Plateau 2 functionality

End user service level 4: "other static information added"

Additional **static information** is added to the RAZ profile (e.g. include bridge heights and allowed tonnage). This information is also shared with road users.

- ✓ Optional plateau 2 functionality

12. INFORMATION ARCHITECTURE - EZ

12.1 Sequence diagram

The **information architecture** (IA) is an elaboration of the sequence diagram originally produced for Activity 3. It contains processes (green) and interactions (red) between processes. The processes are functional and in general conducted by one stakeholder as an internal process. A process receives and collects data, enriches the data and produces information as a product. Information is sent via protocols to other processes in the architecture.

The functional process starts with step 1 (update zone) and continues all the way to step 12 (provide service).

Different data flows can be identified:

- Step 1 to 4: distribution chain of the **static** information to Service providers (plateau 1: dotted line)
- Step 5 to 9: triggering and activation of legal measure on the street; distribution chain of the **dynamic** information to Service providers (added in plateau 2)
- Step 10 to 12: **activation** of individual info/routing (plateau 1)

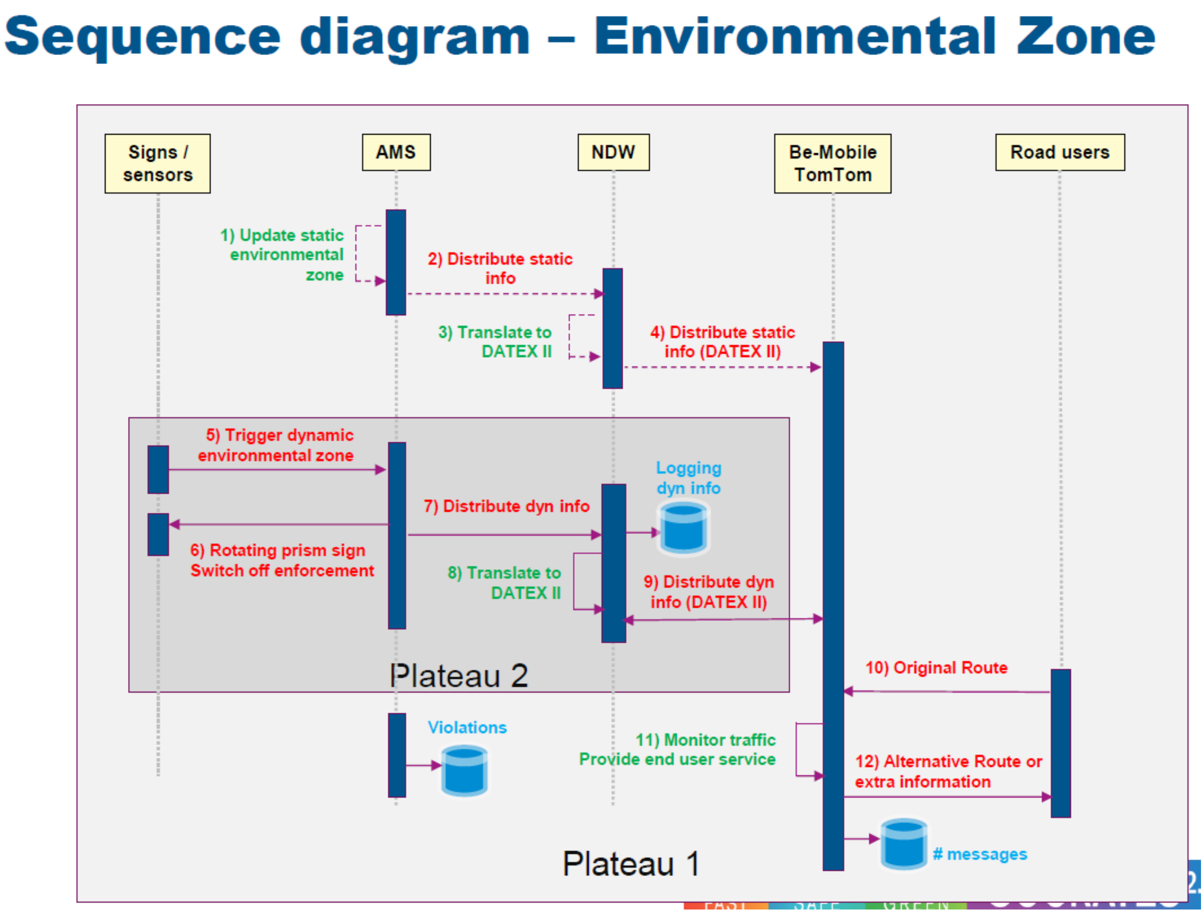


FIGURE 17. SEQUENCE DIAGRAM ENVIRONMENTAL ZONE AMSTERDAM

12.2 Processes and interactions

Step 1: Update static Environmental Zone (AMS)

The real environmental zone in Amsterdam is documented as a GeoJSON format. This is considered as static EZ information. The exact location of the zone is already known and detailed. Possibly the Environmental Zone will be changed in October 2020. So, for the duration of the project this is not an issue. In general changes occur not very often.

Step 2: Distribute static info (AMS)

At the moment the geographical data of the Environmental Zone is available on the Amsterdam website. Click this LINK to access the website. However, Amsterdam can deliver this data in any known format.

https://data.amsterdam.nl/datasets/ot28M5SZu0h9PA/

The main purpose of this data is sharing the geographical zone information as static information. Unfortunately, this original data source is not suited for (more advanced) navigation services. Therefor we improved the information by adding more details to the polygons.

Step 3: Translate to DATEX II (NDW)

NDW incorporates the static data (polygons) from Amsterdam to DATEX II RAZ (restricted access zone). The DATEX II RAZ profile is developed in cooperation with the SOCRATES$^{2.0}$ TMex group. The RAZ profile can also be used for other similar purposes (e.g. bridge heights, tonnage allowance, etc). Exceptions are written in OpenLR.

Step 4: Distribute static info via DATEX II (NDW)

The Network Monitor (NDW) publishes the static EZ information. This occurs one or two times during the project. The receiving partners (TomTom and Be-Mobile) configure this in their own systems. Note that the official NDW publication of RAZ (static and dynamic) will be part of plateau 2. For plateau 1 the RAZ consists of static data only. Publication via email.

Step 5: Trigger dynamic EZ (AMS)

For some events in the RAI venue or based on congestion, the TMC can decide to reroute trucks and buses via an alternative route towards the highway A10. Up to 60 times a year this trigger will be activated.

Step 6: Rotation Prism sign, turning off EZ (AMS)

By activating the prism signs, this new route becomes a legal (or non-restricted) route for trucks, buses and coaches. The Environmental Zone becomes a bit smaller.

Step 7: Distribute dynamic info (AMS)

A DVM-X message is sent from Mobi-Maestro or the central Parking system. The message should be interpreted as an activated DVM-service (e.g. TalkingTraffic project on sharing DVM-services).

Step 8: Translate to DATEX II RAZ (NDW)

The Network Monitor translates this DVM-X message to a DATEX II RAZ dynamic trigger. This will not been done in the '*intekentool*'; instead it will be a separate created message.

Step 9: Distribute dynamic info via DATEX II (NDW)

A “small” dynamic DATEX RAZ message is sent to notify the service providers that an alternative route is available for trucks and buses due to congestion and or events in the RAI venue. A second message is sent to indicate the service should be terminated.

Step 10: Original routes are chosen by road users

Road users (trucks, buses/coaches) choose routes that might include this Amsterdam Environmental Zone.

Step 11: Monitor traffic, calculate route (SP)

Check RAZ change for service level 2 and higher. Internal process of service providers to provide the best solution for their clients (trucks, buses/coaches) based on road conditions, environmental zones and personal preferences.

Step 12: Providing service / type of service (SP)

Service providers provide services to road users (see chapter on end user services 1.3).

13. SYSTEM ARCHITECTURE - EZ

13.1 System / Application overview (plateau 1)

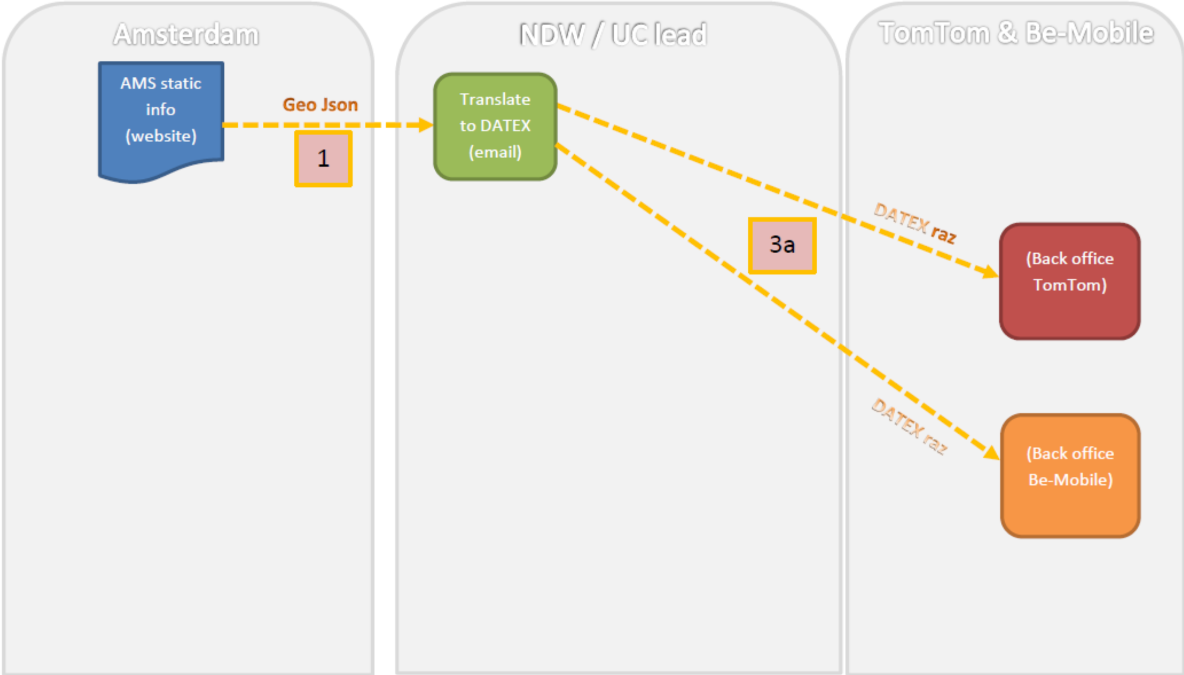


FIGURE 18. SYSTEM OVERVIEW PLATEAU 1 - ENVIRONMENTAL ZONE AMSTERDAM

13.2 System / Application overview (plateau 2)

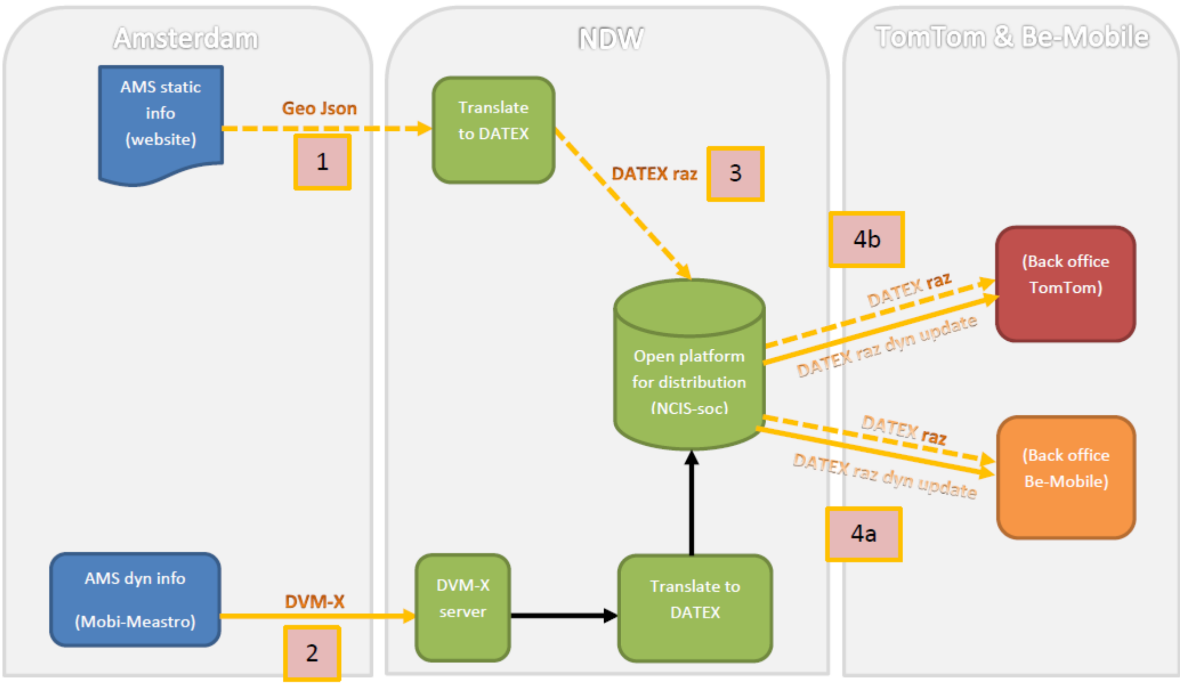


FIGURE 19. SYSTEM OVERVIEW PLATEAU 2 - ENVIRONMENTAL ZONE AMSTERDAM

13.3 Overview interfaces

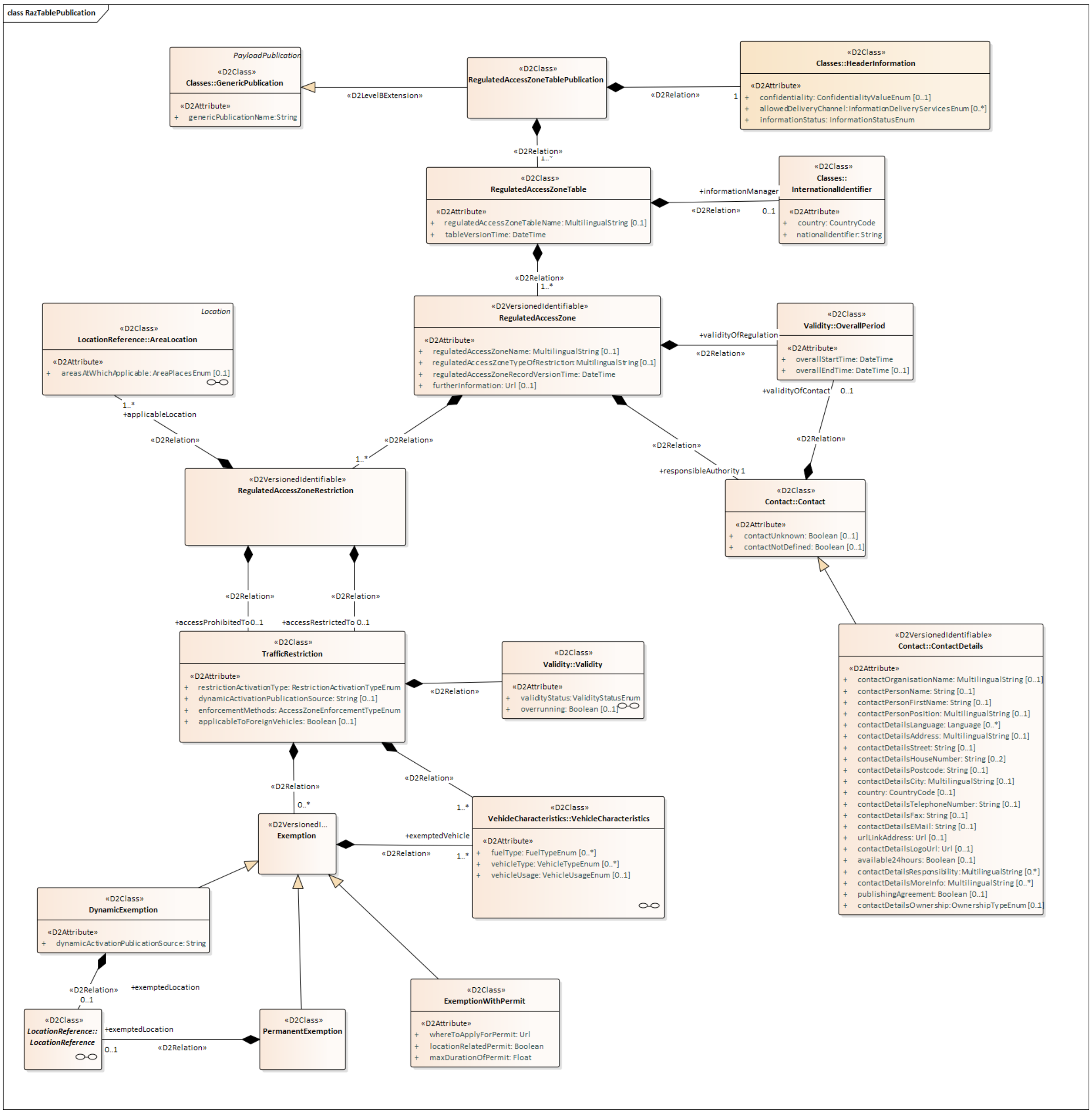
An overview of the identified interfaces is shown in the application architecture. In this picture internal (black) and external (orange) interfaces are shown; numbers 1, 2, 3, 4a and 4b. The internal black interfaces are not described in detail. Partners are responsible for own internal interfaces. Dotted lines represent manual processes, full lines represent automated processes.

The external orange interfaces are shown in the table below.

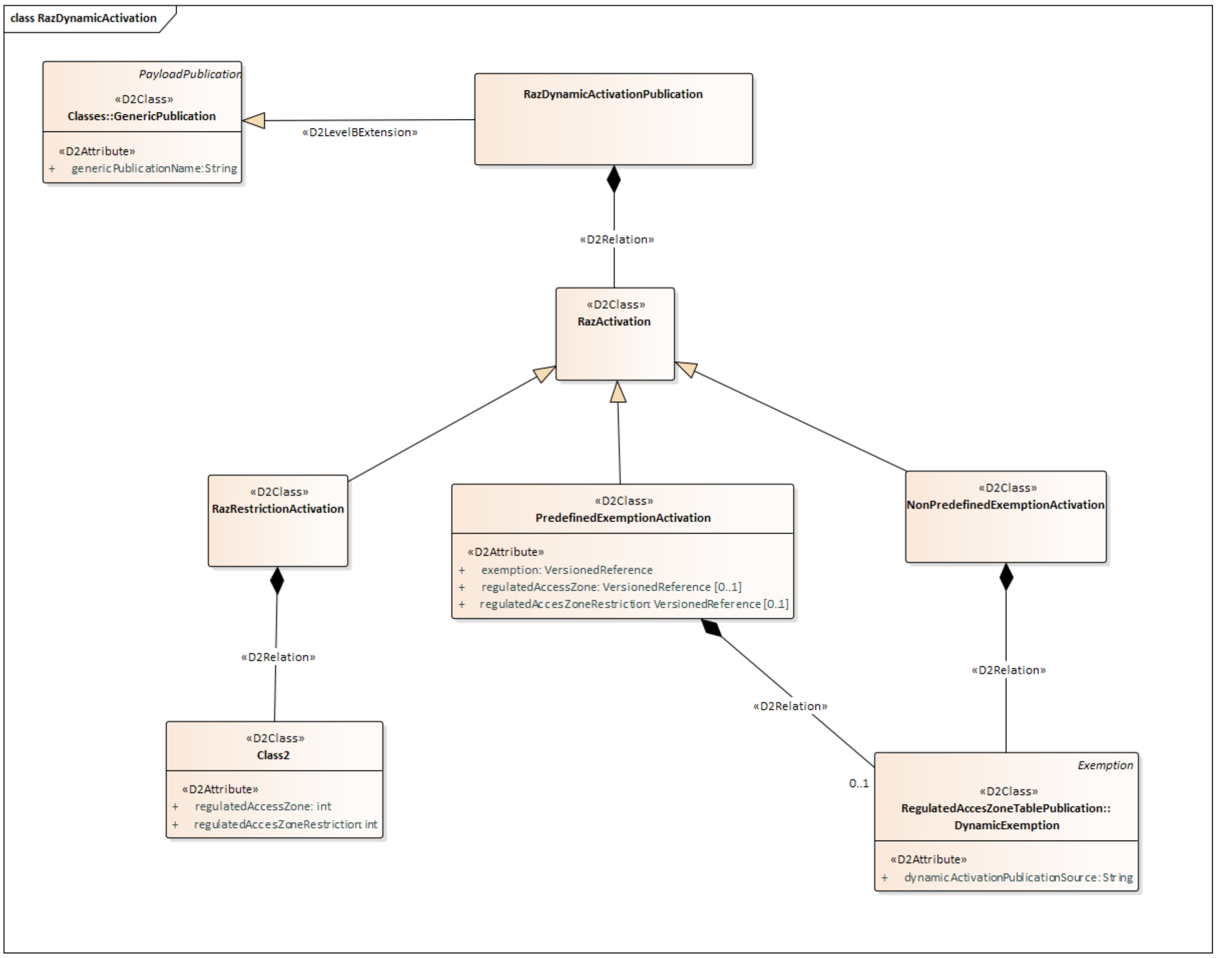
ID	Partner (system/app)	Information	Status
EZ_AMS_1	AMS (website) – NDW (manual handled)	Original source for the EZ static information	Existing source Existing interface New receiver
EZ_ AMS_2	AMS (MM) – NDW (DVM-X server)	Original source and trigger for the EZ dynamic information	Existing source Existing interface New receiver
EZ_ AMS_3a (plateau 1)	NDW (manual handled) – email	Result of translation to DATEX RAZ – static only	Existing source Existing interface New receiver
EZ_ AMS_3	NDW (manual handled) – NDW (NCIS)	Result of translation to DATEX RAZ (improved version) – static only	Existing source New interface New receiver
EZ_ AMS_4a	NDW (NCIS) – Service Providers – static publication	Publication of static EZ info	New source New interface New receiver
EZ_ AMS_4b	NDW (NCIS) – Service Providers – dynamic publication	Publication of dynamic EZ info	New source New interface New receiver

13.4 Interface 4a and 4b description (TMex)

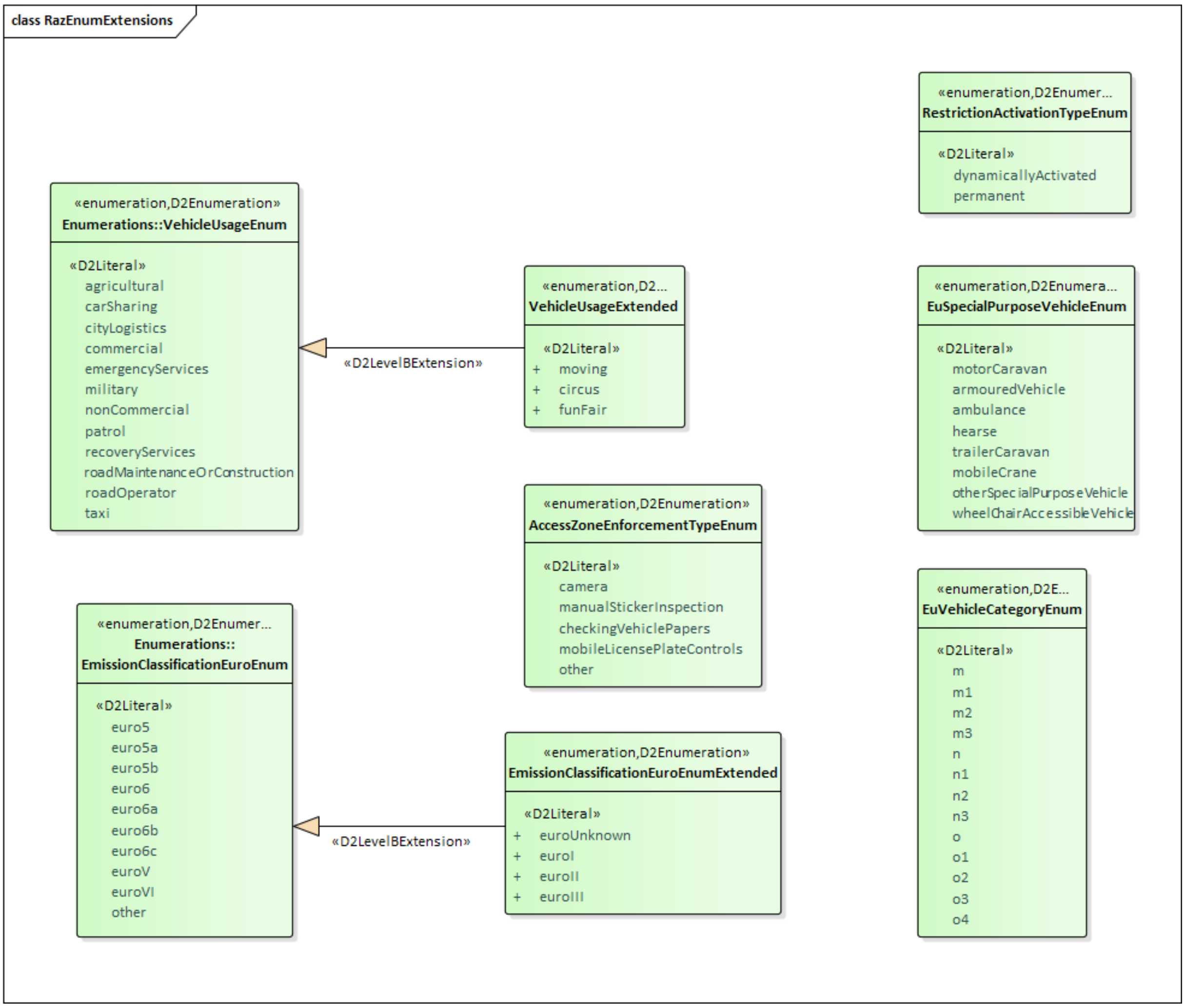
Static RAZ publication



Dynamic RAZ publication



Enums


class RazEnumExtensions
«enumeration,D2Enumer...
RestrictionActivationTypeEnum
«D2Literal»
dynamicallyActivated
permanent
«enumeration,D2Enumeration»
Enumerations::VehicleUsageEnum
«D2Literal»
agricultural
carSharing
cityLogistics
commercial
emergencyServices
military
nonCommercial
patrol
recoveryServices
roadMaintenanceOrConstruction
roadOperator
taxi
«D2LevelBExtension»
«enumeration,D2...
VehicleUsageExtended
«D2Literal»
+ moving
+ circus
+ funFair
«enumeration,D2Enumera...
EuSpecialPurposeVehicleEnum
«D2Literal»
motorCaravan
armouredVehicle
ambulance
hearse
trailerCaravan
mobileCrane
otherSpecialPurposeVehicle
wheelChairAccessibleVehicle
«enumeration,D2Enumeration»
AccessZoneEnforcementTypeEnum
«D2Literal»
camera
manualStickerInspection
checkingVehiclePapers
mobileLicensePlateControls
other
«enumeration,D2E...
EuVehicleCategoryEnum
«D2Literal»
m
m1
m2
m3
n
n1
n2
n3
o
o1
o2
o3
o4
«enumeration,D2Enumer...
Enumerations::
EmissionClassificationEuroEnum
«D2Literal»
euro5
euro5a
euro5b
euro6
euro6a
euro6b
euro6c
euroV
euroVI
other
«D2LevelBExtension»
«enumeration,D2Enumeration»
EmissionClassificationEuroEnumExtended
«D2Literal»
+ euroUnknown
+ euroI
+ euroII
+ euroIII

14. OPERATIONAL PILOT

In Activity 3 the functional design of the use case Optimising Network Traffic Flow has been described and approved by the SOCRATES$^{2.0}$ Steering Group in October 2018. In Activity 4 this functional design is elaborated in multiple more detailed designs. Based on this latter design the pilot is developed.

14.1 Recruitment

Development of end-user recruitment for ONTF and EZ in the Amsterdam pilot site. A number of actions and initiatives were carried out:

- A dedicated recruitment website was built and launched in October 2019 and ongoing updated keeping pace with the recruitment activities in the pilots. The site contains an overview of all pilot sites and all use cases that are deployed. Visitors can register for the different services that become available per pilot city. For Amsterdam:
    - https://register.socrates2.org/amsterdam (Dutch and English)
- Dedicated Facebook campaigns were prepared and executed for recruitment in Amsterdam.
- Communication for Recruitment:
    - Factsheets/QandA for each use case in Amsterdam, language specific
    - Several video's for recruitment and information, language/use case specific:
        - NDW - SOCRATES2.0 - YouTube
        - Navigation service with information on environmental zones in the Amsterdam region (youtube.com)
        - Navigatiedienst met informatie over milieu zones in de regio Amsterdam - YouTube
        - Proactief route advies in de regio Amsterdam (youtube.com)
        - Proactive route advice in the Amsterdam region. - YouTube
    - Detailed invitations in different languages to participate in the pilots published on partner websites and local media
    - Specific slide decks to present Amsterdam activities
- Specific online campaigns for user recruitment by service providers

Additionally, the Netherlands National Broadcasting Foundation has written an article and broadcasted a video in which the SOCRATES$^{2.0}$ is presented as a solutions for current problems that occur when navigation services reroute via local roads (all in Dutch):

Article: https://nos.nl/op3/artikel/2325704-file-dan-rijden-we-met-z-n-allen-om-door-hetzelfde-dorp.html

Video: https://www.youtube.com/watch?v=WZjXv6zeWUo

14.2 Impact of Corona

Corona had a severe impact on the functional piloting of the services developed to test the use cases.

For the ONTF use case, traffic was nowhere near normal intensities. This resulted in far less congestion than before the Corona period. This, in turn, diminished the cause for necessity of alternative routes, since the preferred routes of users were not affected by congestion and users could take those routes free-flow. This led to far less enthusiasm for the recruitment of end users for this use case than anticipated. Additionally, the prediction engines were not calibrated on traffic flow suffering from Corona, resulting in less qualitative predictions as would have been the case in normal circumstances.

For the Smart Destination use case, the impact was even worse, since no events were organised, leaving the use case with no practical circumstances to test the benefits for event public.

For the Road Works use case, the impact was less severe. However, this use case suffered from technical obstacles that proved hard to overcome. Difficulties as to establish the ground truth of where the actual road works took place made it difficult for proper fusion of data collected by the data providers. Furthermore, different profiles used by the data providers and the use of DATEX-II also did add to technical challenges.

For the Environmental Zone information use case, Corona also had a severe impact. The dynamic nature of the use case, where the route to the RAI building is either accessible or prohibited, remained static, since the RAI building is used for events and those were all cancelled.

Nevertheless, the organisational and technical set-up and execution of all use cases were tested and could be evaluated. This was also the case for the functional evaluation of the ONTF use case, the Road Works use case and the Environmental Zone information use case, although the circumstances were far from optimal. Additionally, a friendly-user test for the Smart Destination use case was also executed, providing at least some useful information for the functional evaluation of this use case.